THIRD ANNUAL REPORT SAN FRANCISCO OAKLAND BAY BRIDGE

Note—

⸿ This is Volume III of a series of annual reports on the construction progress of the San Francisco-Oakland Bay Bridge.

⸿ Volume I contained material on legislation, financing, preliminary design, general description, and construction progress to June 30, 1934.

⸿ Volume II told of construction developments from July 1, 1934, to June 30, 1935.

⸿ This volume describes the work accomplished from July 1, 1935, to June 30, 1936.

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THIRD ANNUAL PROGRESS REPORT SAN FRANCISCO OAKLAND BAY BRIDGE

. . JULY 1, 1936 . .

This copy of the Third Annual Report of the progress of construction as of July 1, 1936, of the San Francisco-Oakland Bay Bridge, which has been published to provide the authorities having interest therein with a complete record thereof, is issued to

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GOVERNOR FRANK F. MERRIAM

Chairman, California Toll Bridge Authority

THE SAN FRANCISCO–OAKLAND BAY BRIDGE

***Designed and Constructed by the* DEPARTMENT OF PUBLIC WORKS *of the* STATE OF CALIFORNIA *for the* CALIFORNIA TOLL BRIDGE AUTHORITY**

CALIFORNIA TOLL BRIDGE AUTHORITY: Frank F. Merriam, *Governor;* George J. Hatfield, *Lieutenant Governor;* Earl Lee Kelly, *Director, Department of Public Works;* Arlin E. Stockburger, *Director, Department of Finance;* Harry A. Hopkins, *Chairman, Highway Commission.*

SAN FRANCISCO-OAKLAND BAY BRIDGE DIVISION *of the* DEPARTMENT OF PUBLIC WORKS: Earl Lee Kelly, *Director;* C. H. Purcell, *Chief Engineer;* Chas. E. Andrew, *Bridge Engineer;* Glenn B. Woodruff, *Engineer of Design.*

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BOARD OF CONSULTING ARCHITECTS: Arthur Brown, Jr., John J. Donovan, Timothy L. Pflueger.

CONSULTING GEOLOGIST: A. C. Lawson.

ATTORNEYS: Heller, Ehrman, White & McAuliffe.

Aerial View Looking Toward Oakland, May 15, 1936

Preface

The third year of the construction of the San Francisco-Oakland Bay Bridge has come to a close. It has been a period of intensified interest in the completion of the great structure of steel and concrete.

Amazingly, in twelve months the bridge has developed from a skeleton of piers, towers, and catwalks into an aerial highway, over which, in a few short months, trucks and motor cars will be speeding.

This volume is history in a sense that it presents an epic of the modern world. In matter-of-fact form the Chief Engineer has presented the story of the construction of the world's largest bridge as a report of month-by-month progress. But the drama behind the building of this bridge is felt in the simple presentation of the facts contained herein.

Frank F. Merriam

FRANK F. MERRIAM
Governor

To His Excellency, FRANK F. MERRIAM, *Governor of California, and Members of the California Toll Bridge Authority*

GENTLEMEN:

There is transmitted herewith the Third Annual Progress Report of Chief Engineer C. H. Purcell covering the construction of the San Francisco-Oakland Bay Bridge from July 1, 1935, to June 30, 1936. This marks the third year of the construction period of this great bridge.

It had been contemplated to make this volume the third and final of the series of progress reports, but it has been thought expedient to produce a fourth report, which will include the completion of the bridge for automobile and truck traffic; and all work on the bridge railway project.

The State Department of Public Works takes pleasure in transmitting this third report of the work under the direction of this department.

Respectfully submitted

Earl Lee Kelly

EARL LEE KELLY
Director of Public Works

To the Honorable **EARL LEE KELLY,** *Director of Public Works*
of the State of California

SIR:

Submitted herewith is the Third Annual Progress Report of the construction of the San Francisco-Oakland Bay Bridge covering the period between July 1, 1935, and June 30, 1936.

In this report will be found the record of progress of the contracts under way during the year and summaries of the new contracts awarded.

We have not duplicated in this third volume any material published on the construction of the project previous to July 1, 1935.

Three of the construction contracts on the San Francisco-Oakland Bay Bridge were completed prior to this date and were covered in the previous reports. These contracts include:

Contract No. 2—West Bay Substructure,
Contract accepted May 29, 1935.

Contract Nos. 4 & 4A—East Bay Substructure,
Contract accepted January 18, 1935.

Contract No. 8—Concrete Girder Spans on the Mole,
Contract accepted March 29, 1935.

Respectfully submitted

C. H. PURCELL
Chief Engineer

Cable Spinning at Night; San Francisco in the Background. December 10, 1935

Annual Progress Report No. III

San Francisco Cable Anchorage and Shore Piers

[Contract No. 3]

Progress July 1, 1935, to June 30, 1936

Cable Anchorage

The first stage of the anchorage to Elevation + 52 was completed on March 12, 1934. After completion of the cables for the west half of the West Bay Crossing, work on this unit was resumed on November 1, 1935.

After this date, the work progressed rapidly with the seats for the continuous truss spans at Elevation + 113 completed in March, 1936. The truss was landed on these seats on April 15, 1936. By June 30, the lower deck roadway and the walls supporting the upper deck had been completed. A total of 65,600 cubic yards of concrete has been placed in the anchorage to date. **Continuous Truss Spans Landed**

All concrete below Elevation + 76 was placed with a guy derrick and bottom dump buckets. Above this elevation the concrete was raised by a tower and distributed by buggies.

Viaduct

By June 30, 1935, the piers for the five 65-foot spans of the double-decked viaduct, reaching from the anchorage to Rincon Hill, had been completed to the bottom of the lower deck concrete girders. During the past year work on this part of the structure was continued so that by May 10, 1936, the concrete girders and slabs of the lower deck, the columns between the upper and lower decks, and the upper deck girders and paving slabs were finished. There remain only the concrete railings to be completed.

Piers "A," "B" and W-1

Piers "A" and "B" were completed in the previous fiscal year. Pier W-1 was also finished during the same period, except for concrete pilasters extending from the bridge seats to the railing level at the upper deck. These concrete pilasters still remain to be completed.

Equipment

The equipment in use on this contract was described in the previous annual report and no new methods have been introduced. A high standard of proportioning, mixing and placing concrete has been maintained, and through the use of plywood forms a high standard of concrete finish has been achieved.

Personnel

This contract is held by the Healy-Tibbitts Construction Company, C. C. Horton, President, and Alec Cochrane, Field Superintendent. N. W. Reese is Resident Engineer for the State.

Yerba Buena Island Anchorage, Piers and Tunnel

[[Contract No. 5]]

Progress July 1, 1935, to June 30, 1936

Yerba Buena Cable Anchorage

On June 30, 1935, the concrete had been placed to Elevation + 118.5. The structural steel cable bent had been erected. The eyebars, except for the last length connecting to the strand shoe assembly, had been erected in the Yerba Buena anchorage tunnels and the concrete encasement around these eyebars and the steel grillages had been placed.

The concrete walls of the anchorage were raised to Elevation + 140 by August 25, 1935. Operations were suspended after this date until February 17, 1936, during which period the cables for the east half of the West Bay Crossing were spun. Concreting operations were then resumed and the anchorage was practically completed by June 30, 1936. The concrete plans for this anchorage were revised during the year so as to provide a connection for future additional roads on the island.

Main Tunnel

By June 30, 1935, the side walls of the tunnel had been finished; 350 feet of the arch ring had been excavated, the roof being supported by the steel arch girders, and for a length of 80 feet these girders had been encased in concrete.

During the past year the tunnel has been completed except for the tile lining placed under another contract.

Tunnel Concrete

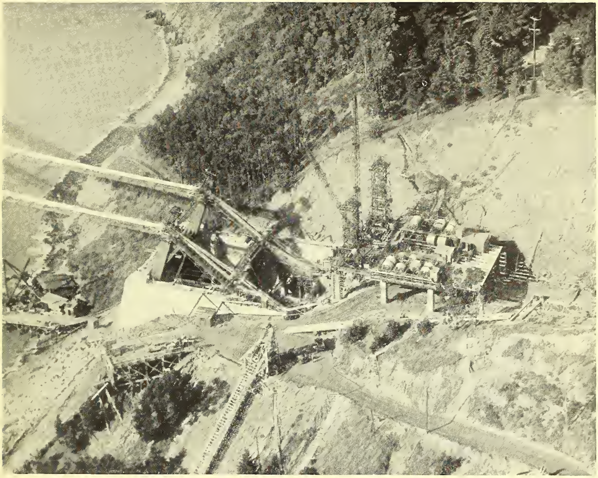
The contractor continued the use of the two sets of steel forms, which forms were made up in panels 20 feet in length, extending the full width of the tunnel, mounted on a car, or Jumbo, resting on rails supported on the rock core. Concrete was mixed at the main concrete plant and transported to a concrete pump which was located at the west end of the tunnel. The supply pipe from the pump to the concreting operations was carried in a monkey drift about four feet square, above the concrete lining. This monkey drift was later filled with concrete, using a Hackley gun. The concrete in the roof was completed on October 19, 1935.

Grouting

After completion of the concrete arch, holes were drilled 10 feet on centers in five longitudinal lines 10 feet apart, and grouted with one part cement, two parts sand, at a pressure of 30 pounds per square inch, an average of 2.3 sacks of cement per cubic yard being used. After this grouting had been done, holes spaced 40 feet on centers on lines 30 feet from the arch centerline were drilled, and grout applied. These holes, however, refused to take grout, indicating that the first grouting operation had filled all voids between arch ring and the rock.

Core Excavation

As the roof concrete progressed from both ends of the tunnel toward the middle and the grouting was completed in each such successive section, the contractor started excavation of the core, working alternately on the west and east ends. The rock was loosened by blasting and loaded on trucks by power shovels. The excavation of the core was started July 25, 1935, and completed November 18 of the same year. Through the tunnel the railroad is approximately four feet deeper than for the lower deck. Excavation for this deepened section was handled as a separate operation and completed on November 27, 1935. As was anticipated, there was a



Aerial View of Cable Spinning Operations at Yerba Buena Island Anchorage, January 15, 1936

shrinkage crack at the joints between the successive 19.5-foot sections which were filled, after concreting the tunnel roof. These joints were chipped out to a depth of three inches and calked with a dry mortar containing ironite. This operation effectively stopped all water flow which had been previously coming through these joints and forced into drains provided for such purpose in the tunnel sidewalls.

Tunnel Portals

The excavation for the East Portal was completed October 24, 1935. The placing of concrete started on October 3, and was completed December 19. Placing of Portals

For the West Portal concrete was started December 1, 1935, and completed June 1, 1936. In placing these portals all possible attention was paid to securing true lines and good surfaces. Five-eighths inch plywood panels four feet by eight feet in dimension, supported by two inch by six inch studs on twelve inch centers and two inch by six inch walers on twenty-four inch centers were used in forming the exposed surfaces.

Viaducts

The upper roadway across the island between the East and West Bay steelwork is carried on a reinforced concrete viaduct. By June 30, 1935, this viaduct had been completed, except for railings from a point 100 feet east of the East Portal tunnel. The viaduct from this point west to the connection with the West Bay steelwork was completed, except for a short section of handrails, by June 30, 1935.

Excavating the Last of the Tunnel Core, November 18, 1935

Lower Deck Pavement

Across the island between the two steel structures, the lower deck concrete paving is supported by earth or rock subgrade. The placing of this pavement was started December 23, 1935, and 95 per cent completed by June 30, 1936.

The general procedure in this work was to prepare and compact the subgrade, set header-boards and pour the concrete in three 10-foot lanes. Concrete was delivered in trucks, placed on the subgrade, compacted with internal vibrators, after which it was screeded and broomed to obtain the desired finish. The impervious membrane process was used in curing.

Roads and Utilties

In addition to the work on the bridge proper, work has been continued during the past year on the relocation and resurfacing of such of the island roads as were affected by our operations.

Personnel

The contract for this work is held by Clinton Construction Company, of which W. B. Brinker is President and Albert Huber, Vice President. Lieutenant Commander Collins Macrae, U. S. N., and Lieutenant H. A. Bolles, U. S. N., have represented the Commandant of the Twelfth Naval District. Harry Carter is Resident Engineer for the State.

West Bay Superstructure

[Contract No. 6]

Status of Contract June 30, 1935

By June 30, 1935, the four main towers: W2, W3, W5, and W6; the San Francisco Cable Bent, W1; the Yerba Buena Anchorage Bent, W7; and the steel "A" frame at the center anchorage had been completed. The catwalks for the west half of the West Bay Crossing had been completed and cable spinning had started on this section June 15.

Cable Spinning

Spinning of the cables for the west bridge, San Francisco to the center anchorage, was continued to completion October 16, 1935. Equipment was then transferred from San Francisco anchorage to Yerba Buena anchorage and modified at the center anchorage for the spinning of the east bridge cables. This last was accomplished in the period November 12 to January 20, 1936.

Methods of erecting catwalks and spinning cables were described in the Second Annual Report. With experience, rate of spinning was accelerated. East bridge Work Schedule cables were spun in 70 elapsed days while west bridge cables required 124 days. At the peak of production, a working week included six working days of 21 spinning hours, with the men organized in three shifts of seven hours each. This left three hours each day for necessary maintenance of equipment and for cutting out and replacing the small amount of wire which did not meet specification requirements.

During spinning of the west cables, June to early October, the fresh westerly trade winds in the afternoon made proper adjustment of wires difficult, and crews were therefore organized on the basis of a shut-down period in the afternoon. Later, during east cable spinning, afternoon winds had moderated and caused no interference to wire adjustments. The shut-down period was advanced from seven to ten a.m. In any particular cable, spinning of the four strands of 472 wires each for one set-up was completed in about three days. This was followed by two or three days for banding and adjusting strands, placing eyebars, strand shoes and guide wires for spinning the next set-up of strands.

In all, 19,112 tons or 70,649 miles of cable wire were spun into the four main cables. Progress at times was record-breaking, the following performances exceeding previous marks for earlier bridges:

Wires spun	*Number*	*Weight in tons*
In one cable in one day	836	211
In two cables in same day	1488	377
In one cable in one week	2856	723
In two cables in same week	4744	1201

Each cable was made up of 37 strands—such strands with diameter of five inches constituted the largest diameter spinning and adjustment units yet attempted. In order to effect "in place spinning" and permit adjustment of the individual wires,

strand shoe anchorages were shimmed back so that strands, at mid-span, were one to one and one-half feet above normal position in the cable. Occasionally, on hot days, the wire temperatures in strands being spun rose more rapidly than the greater mass of spun wires in the main cable, with the result that the relative increase of spinning strand lengths dropped them onto the main cable and temporarily interrupted work.

Spinning Adjustments

After spinning the set-up of four strands, each strand had to be adjusted by longitudinal movement over tower saddles and the removal of shims at the anchorages. The initial, and major adjustments, involving the removal of about nine inches of shims at each anchorage, were usually made to approximate measurements during the day on completion of strand banding. Final adjustments were effected after midnight when temperature differences in component parts had reached more nearly stable conditions. On final adjustments, the temperatures of strand units and of main cables were determined, strand heights noted at mid-span, and strands set to final position in the cable by careful calculation and measurement thus assuring equal participation of the bridge load by each strand. As each strand had a tension greater than 70 tons and a bearing of 60 tons at tower saddles, adjusting movements of as much as 11 inches and as precise as one-eighth inch required powerful and well-controlled equipment.

Usually, at spinning tramway frames, strands were partially lifted in the span away from which strand movement was desired. This increased the resultant pull at the saddle and with a 10-ton ratchet jack as a booster was sufficient to slide the strand through the saddle until the proper position had been reached. At strand ends on the anchorages, 75-ton hydraulic jacks on the strand shoes moved them to the proper position where they were held by shims adjusted to the nearest one-sixteenth inch.

Spinning Delays

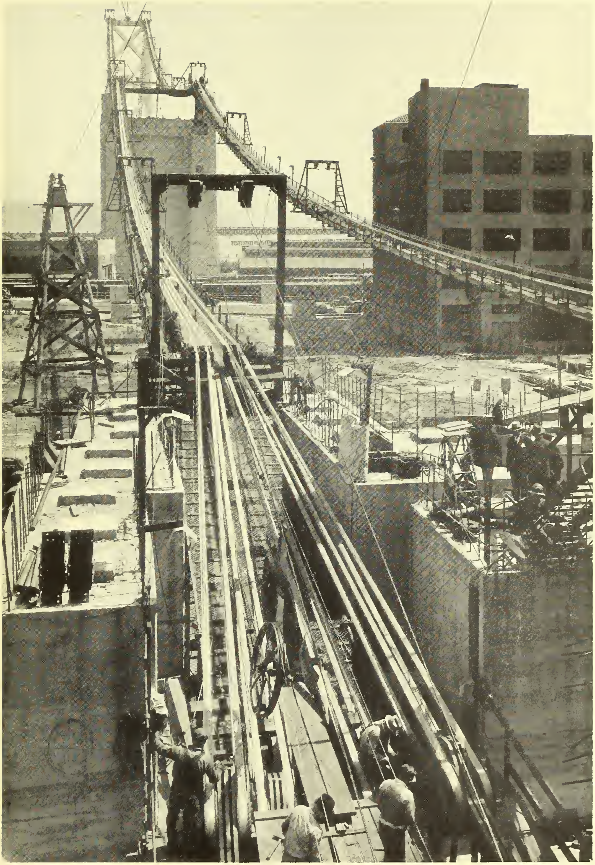
In addition to the occasional spinning delays due to temperature, there were, at times, short delays caused by the adverse winds, previously mentioned. Such delays were reduced by proper manipulation of working periods for spinning. Loss of one strand by turning of a strand shoe resulted in a delay of ten days and the junking of 140 tons of wire.

Compacting of Cable

Following spinning and adjustment of strands, the 37 strands forming each main cable were banded by wooden clamps into hexagonal sections with top and bottom faces horizontal. These clamps at 50-foot intervals, were set from midnight to six a.m., when distortions of the cables from temperature were at a minimum. Special machines then completed the final forming by compacting the strands into a circular cable 28.84 inches in diameter, held to shape by temporary wire seizings every three feet. This machine used six radial jacks around the circumference of the cable with each jack exerting a force of some 75 tons. Voids between the individual wires were reduced to 19.6 per cent by the compaction. Wood cable clamps were removed as they were approached by the compacting machine. West bridge cable compacting was completed on November 12, 1935; east bridge compaction on February 4, 1936.

Cable Bands

Cable bands of cast steel, over which suspenders were to be looped, were then clamped onto the compacted cable and secured against slipping along the cable by two-inch diameter high-tensile bolts, each tightened to a specific stress of 68,000 pounds. On the short bands, over nearly horizontal portions of the cable, eight bolts were used. These were increased to 16 bolts on the longest bands over steepest



Cable Spinning Operations at San Francisco Anchorage, July 31, 1935

portions of the cables. One band was required at each point of support for the suspended structure, approximately every 30 feet measured along the bridge deck. A total of 604 bands was used averaging 2240 pounds each. These were completed on the west bridge on January 31 and on the east bridge February 21.

At anchorages, spread of cable strands was secured by large splay castings, held from slipping by friction collars bolted to grip the cables. Cable band and friction collar bolts were retightened from time to time to maintain proper friction as cable diameter decreased with stretching of the cable during erection of trusses and decks of bridge. Initial bolt tightening and later retightening were controlled by measuring strains with special calipers. During major loading of the cables, the critical friction collar bolts were tightened about once a month; remaining bolts were kept above a minimum tension of 30,000 to 40,000 pounds per bolt.

Suspender Ropes

With band erection completed, catwalks were supported by light wire rope slings at ten-foot intervals along the cable, releasing the two and a quarter-inch diameter steel ropes which had acted as suspension bridges. These steel cables had previously been pre-stressed and marked into proper lengths for later cutting and inclusion into part of the suspender rope system. They were cut at the marked points while resting on the catwalk, then transferred to Pier 24 where cast steel sockets were attached. These were placed over ends of ropes and held by splaying the individual wires inside the socket. The socket was then filled with zinc spelter. These, and other pre-stressed suspender ropes socketed in the east, were then hung in pairs on each cable band ready for stiffening truss loads.

Suspenders for the west bridge were completed on January 30, and for the east bridge on April 11, 1936.

This work finished the cable and suspender system, excepting the seal rings, and the protective wrapping for the cables.

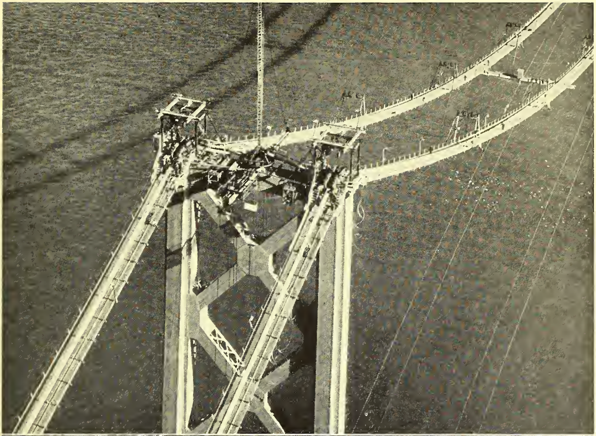
Cable Wrapping

The main cable wrapping protects the most vital elements in a suspension bridge. To insure its adequacy, red lead paste was applied just ahead of a special wrapping machine. This machine then wound the serving wire under tension in continuous coils around the cable, at the same time crowding the coils together to form an unbroken wire metal seal between cable bands. Where the wrapping joined the cable bands, and between halves of the bands, water-tightness was secured by lead wool caulked into prepared grooves. Wrapping has been completed over the west main and one side span and is 44 per cent completed for the entire bridge.

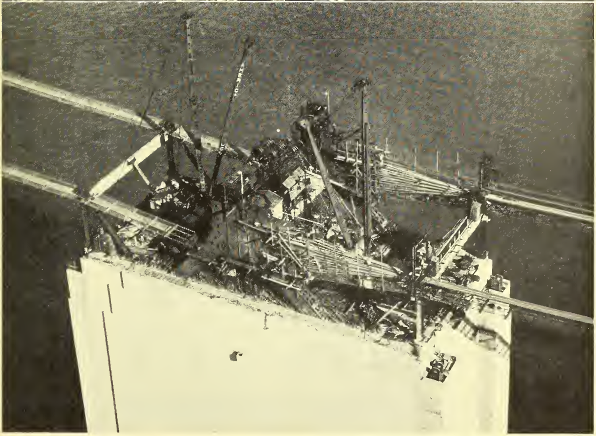
Placement of Tower Saddles

An interesting problem of cable spinning, and one which later involved span erection, concerned the placement of tower saddles so that wires would not tend to slide through the saddles, nor towers be deflected too much. Differences in the effect of cable movements under loading in the main spans also required that finally towers lean away from the main spans with full dead load on the structure. Results could be achieved during spinning by deflecting the towers with special back stays, or by offsetting the cable saddles towards the side spans by amounts varying from eight inches at Tower 3, to four feet eight inches at Tower 2. This latter greater distance was due to effects of the unloaded main cable back stay from San Francisco anchorage to Bent 1. The contractor chose to effect the various requirements by offsetting the cable saddles during spinning.

After completion of spinning, and at predetermined stages in span erection, as governed by tower deflections, jacks were used to center the saddle and top of the



Aerial View of
Spinning Operations
in Cable Saddles
on Tower W-3



Spinning Operations
on the
Center Anchorage

Lifting One of the Units of Steel Trusses of the West Bay Crossing, January 24, 1936

tower. About 80 per cent of the relative movement was a deflection of the tower and the other 20 per cent an opposite shift of saddle and cable together. The centering of each saddle was effected by two 500-ton hydraulic jacks. The bearing of the saddle on the tower cap at such stages reached about 5000 tons maximum. Contact surfaces between saddles and tower caps were paraffined before erection to facilitate the jacking operation.

Suspended Structure

In a suspension bridge, the term "suspended structure" is used to define the steel stiffening trusses, floor steel, pavements, etc., which are hung from the cables by the suspenders. The function of the stiffening trusses is to uniformly distribute any concentrated vehicular or trainloads to the cables so as to avoid the severe distortions that would otherwise occur.

Truss Dimensions

Steel for the suspended span structure of the San Francisco-Oakland Bay Bridge is of Warren type design with 30-foot panels, 30-foot depth, and with trusses spaced 66 feet on centers transversely. It was erected under conditions which involved placement of loads in any span to limit bending of the towers to a safe degree and to limit differential cable pull at the center anchorage to 3100 tons per cable.

Raising equipment for erecting truss steel was provided at four separate points along the bridge; and at additional points, for deck steel erection, to insure the required rate of progress.

The usual construction of spans for major suspension bridges has been effected by erecting fabricated portions of truss steel, piece by piece; working symmetrically outwards from the towers to mid-span, and then working back to the towers with remaining steel.

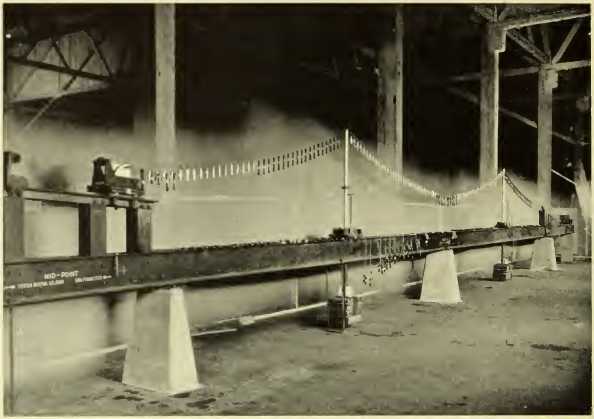
Method of Truss Erection

In contrast, the contractor adopted the method of erecting the major portion of the steel by skeleton units involving both trusses and connecting steel, and beginning at the centers of the main spans, or the ends of the side spans, and working towards the towers. Also to minimize moves of the anchor barges, erection was continued as long as possible in any one direction. The extent of unbalanced erection permitted was limited by the general requirements previously noted. Similarly, deck steel was erected in an unbalanced manner by deck travelers working continuously from tower to tower.

Model Utilized

Long range accurate planning was necessary in consideration of these procedures and because of the three-week cycle from sandblasting to the erection of steel in skeleton units at the yard. This planning was effected by the use of a special bridge model erected on Pier 24. Proposed loads and sequences could be simulated on this model and resultant tower deflections and cable tensions determined. In a relatively short time many different erection combinations could be tested, limiting conditions determined, and the most suitable one selected and followed in organizing construction work at the yard and at the site.

The model, of one cable only, was built to a scale of one part in 100, was 60 feet in length, and had micrometer dials so sensitive that one space on the dial repre-



Model Used in Determining Tower Deflections and Cable Tensions

sented a change in the deflection of a tower of one thirty-second of an inch. As actual loads were applied to the structure, model predictions were verified within close limits [less than 5 per cent] and differences noted so that on succeeding investigations even more reliable predictions could be made.

Panels Erected at Islais Creek

At the Islais Creek yard, the assembly of fabricated members into skeleton units was made on two flat cars running on parallel tracks spread 66 feet apart. Each unit normally included two trusses, each comprising a complete 30-foot panel, with the upper chord extending one panel one way and the lower chord one panel in the opposite direction. Trusses were connected with two bottom and two top floorbeams. In the heavier units considerable deck steel was placed. The assembled unit measured 92 feet in length and was 68 feet wide and 33 feet high over all.

Weights ranged from 125 to 203 tons, though center units in the main spans and first units in side spans weighed generally about 75 tons; single truss units for erection over land or dock structure weighed less than 75 tons. All completed joints were riveted after the unit was assembled. Erection tracks accommodated seven units in a line at one time, and were not arranged for by-passing, so that the predetermined loading order had to be followed.

Floating of Panels

When a unit was assembled and riveted, it was advanced to the loading point on trestles extending into the water. Transportation barges were flooded, brought to position beneath the unit and blocked to it, then the water pumped out thus raising the unit off the flat cars. These barges were then towed to the bridge site and moored alongside another barge anchored under the unit's relative position in the bridge.

Lifting falls were lowered from a pair of traveler cranes riding on top of the main cables. Falls were attached to each corner of the unit which was then raised by tackle lead lines from four separate 175-horsepower gasoline hoisting engines at the nearest tower on the pier base. Electric indicating levels on the unit flashed signals to two control men riding on the traveler cranes. These men during raising kept the units in a level position by signals to the proper hoisting engineer. Normally, engines were run as nearly as possible at the same speed so that few adjustments were needed. Units were lifted a few inches above final relative position, suspender rope sockets placed under the bearing seats on the trusses and the unit lowered until the full weight bore on suspenders. Tackles were then disconnected and traveler cranes advanced to the next position for picking up a unit.

Lifting of Panels

Traveler derricks followed along on the skeleton trusses filling in remaining floorbeams, stringers, steel curbs, and the lateral bracing between units. Materials were lifted directly from barges anchored below, except that over land or docks, pieces had to be lifted and telegraphed, or railroaded, to the traveler. Except for connections to towers or anchorages at ends of the spans, this fill-in was completed on May 21 for the west bridge, and on June 19 for the east bridge.

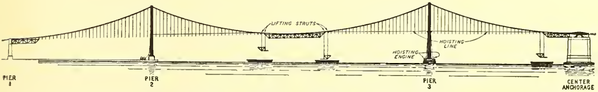
During the later construction period, after being spotted alongside the anchor barge, some units were raised and placed in the structure within less than an hour. The maximum daily rate at this period was three units. West bridge units were erected in the period December 18 to March 10; east bridge units from February 20 to April 30. In all, 146 units were placed in 135 elapsed days. Seven of the east bridge units had to be erected before completion of the west bridge units in order to limit the differential cable pull at the center anchorage. An average of 7.3 units per week was raised from mid-December, 1935, to May, 1936, with a maximum of 14 units lifted during the week ending February 8, 1936. A maximum of 10,800 tons was erected in the month of April. Altogether, 36,400 tons of steel were erected in the seven-month period from December, 1935, to June 30, 1936, completing 94 per cent of suspended span steel.

Rate of Truss Erection

Connections at the ends of the spans provide restraint against lateral forces, particularly wind or earthquake, and also against vertical forces which may act either upwards or downwards according to relative loading on the various spans. These vertical forces are carried through long rocker posts pinned to the towers or to prestressed eyebars at the anchorages. Rocker posts permit the relative longitudinal movements due to temperature and load changes between towers and spans. Continuity of the deck at the towers and anchorages is assured by long steel fingers interlaced over the expansion gaps.

Rocker Posts

In making the connections at ends of the spans the primary considerations were that all truss and bracing steel in the span be erected and satisfactorily pinned and



STIFFENING TRUSS ERECTION

bolted, or riveted. Since connections were made before all structural loads were in place, ends were higher than final design positions and required extraneous forces to haul them down so that the pins could be driven to the rocker posts. Usually such forces were nominal and connections were made without difficulty.

The east bridge was completed on June 24, and the west bridge by June 30, excepting the east side of Bent 1. At this point it is estimated that a downward force of 250 tons will be required on either side of the bridge to make the rocker post connection.

Change of Main Cable Curve

An important element in the erection of trusses was introduced by the wide change in the main cable curve as weights were added. As the first units were erected such changes developed sharp sags in truss profiles, when the bottom chord joints of adjacent units were open as much as a foot, while the top chords butted together. Top chord joints were bolted together, at least in cover plates, with the units in these relative positions. At first, central units in the main spans were as much as 15 feet below the final dead load elevations. As further units were added, profiles straightened and by the time a span had been completed the truss profile was generally curved upwards, reaching a maximum, in the main spans, of some 12 feet above dead load elevation. This was the final relative position in the structure at neutral temperature and with no live load on the bridge. During this transition stage in truss profiles, top chord joints were 60 per cent pinned and bolted by the time lower chord joints had closed. Lower chord joints were 60 per cent pinned and bolted while trusses were in the curved position which brought them together.

Riveting of Truss Joints

Riveting of truss joints was generally effected during, or after deck steel fill-in. Generally, lower chord joints were in compression and could be riveted without difficulty. With trusses curved upwards, top chord joints were generally open one-sixteenth of an inch even though adequately pinned and bolted. As deck steel was placed, it was followed by a relative sag or wave in truss profiles which tightly closed top chord joints ready for riveting. Some of the top chord joints were riveted as this wave followed deck steel placement. In this manner riveting of most of the lower chord joints and 15 per cent of the upper chord joints was completed in the west spans. In the east spans, from the center anchorage to Yerba Buena Island, riveting of lower chord joints in the main span and part of a side span was practically completed. No upper chord joints were riveted in this section.

Closed joints in all spans have been riveted. Deck and miscellaneous steel riveting was effected irrespective of truss profiles in general and is practically completed in the west spans and 80 per cent completed in the east spans.

Number of Rivets

In all, 645,000 field rivets are required for suspended spans. Of these, 97,000 were driven at the Islais Creek Yard in the truss units at joints which could be completed at that stage. Rivets driven at the site total 357,000—completing 70 per cent of all field riveting.

Continuous Spans

Between the suspended spans and the San Francisco anchorage an 852-foot continuous truss with two intermediate supports was required, with the separate spans 378, 96, and 378 feet, respectively. These trusses were built by cantilevering relatively short sections westwards from Bent 1, using four intermediate false bents. The longest cantilever was 189 feet. The main cable backstay passes through this

Steel Hood Erected on Center Anchorage, June 16, 1936

truss and required temporary support for clearing certain members until the cable was raised to nearly final position by added loads in the suspended spans.

Erection Dates

Trusses were erected from February 19th to April 30th. The traveler then backed eastwards to fill in curb sections, completing them on April 30th. Steel for these spans was sandblasted and primed at the Oakland and Islais Creek yards, then shipped piece by piece on cars or trucks to the site for erection.

A feature of continuous span erection is that small fabrication errors or unequal settlement of the intermediate supports can cause relatively large stresses in the structure, both during erection and after completion. Careful level observations were maintained to control elevations at temporary erection bents and to determine elevations at permanent bents. Strain gage measurements were also made at critical sections and showed that planned stresses were not exceeded.

Riveting followed erection closely, the reversing flexures of trusses during different erection stages providing opportunities for driving practically all chord splice rivets when chords were in compression. By May 12th, 63,286 field rivets had been driven, practically completing this work. Spans were released for painting under Contract 9 covering the last three coats of paint.

Anchorage Deck Steel

In addition to the spans, upper deck steel was erected for the 170 feet across Pier W-4 and the 264 feet over Yerba Buena anchorage. Over the San Francisco anchorage, the required 147 feet of deck steel have not yet been placed, as supports are still being constructed under Contract 3.

View Looking Westward from Tower W-3; San Francisco in Background, June 16, 1936

Concrete Deck

Paving of the concrete decks was started on June 18th and is 8.3% complete with 1602 cubic yards in place. The major items of design, equipment and placing procedure were described in the Second Annual Report under Contract 7. Only the modifications required for West Bay construction will be described here.

Pavement Schedules

The most vital difference was that concrete placement in the various spans of the suspension bridge had to be so scheduled as to limit tower deflections to less than 3.5 feet and torsions at tower tops to less than five inches in a width of 66 feet. Also to limit transverse tilting of trusses under unbalanced loads. Furthermore, placement schedules had to be such that the unbalanced pull at the center anchorage, or Pier W-4, should not exceed 3100 tons per cable.

Tower Deflections Limited

The program to satisfy these criteria was submitted by the contractor after it was developed in cooperation with State engineers on the model of similitude erected on Pier 24 and referred to previously in this report. The controlling factors of the adopted program provided that to limit tower deflections or torsions, and the span tilts, the paving should be placed successively in various portions of the main or side spans, excepting the upper deck center lane which was to be placed progressively in west or east spans. To limit the unbalanced cable pull at the center anchorage, approximately half of the suspended span paving west of this pier was to be placed in the manner described. All of the paving east of Pier W-4 and to Yerba Buena Island was then to be placed, followed by completion of west span paving. As spans are paved under this program, actual structural deflections and stresses will be determined, and the schedules modified if values predicted from the model prove too conservative.

View Looking Eastward to Berkeley Hills from Tower W-3 June 16, 1936

West Bay paving was effected with the same batching plant used on the spans east of Yerba Buena Island. The plant was moved without alteration to a leased site at First and Bryant Streets in San Francisco after the site had been graded and reserve storage bins and railroad spurs constructed. A mixing plant with a 56 cubic foot mixer was set up for direct loading from batching conveyors and discharged into a truck loading conveyor with a small storage hopper. Trucks hauled batch units two blocks to the north side of the continuous span bent and dumped them into a hopper-feeding skip, which in turn hoisted concrete vertically 160 feet to charge a storage hopper 20 feet above the upper deck. The dinky train was loaded at this point, and conveyed concrete to the proper location in the deck. Placement, finishing and tile setting were essentially the same as for the East Bay crossing, Contract 7.

Batching Plant

Status of Work June 30, 1936

Contract 6 is 94 per cent complete. There still remain about 2000 tons of steel to be erected; 228,000 field rivets to be driven; and about 18,000 cubic yards of concrete to be placed in pouring slabs and the concrete encasement of the "A" frames at the center anchorage.

Personnel

The contract for the superstructure of the West Bay Crossing is held by the Columbia Steel Company, of which Ambrose Diehl is president. The late E. J. Schneider was succeeded by J. R. Fox as contract manager. The steel was fabricated and erected by the American Bridge Company, of which C. S. Garner is general manager of erection; and H. C. Hunter is western erecting manager. I. O. Jahlstrom is Resident Engineer for the State.

Aerial View of East Bay Crossing, March 25, 1936

East Bay Superstructure

⟦Contract No. 7⟧

Progress July 1, 1935, to June 30, 1936

Status of Contract, June 30, 1935

By June 30, 1935, the last of the 504-foot spans, that between E-4 and E-5, was 50 per cent erected, and the four Yerba Buena spans had been erected. The west anchor arm of the cantilever structure was 75 per cent completed.

Cantilever Erection

The work during the past year has therefore consisted mainly of erecting the cantilever and the placing of the concrete paving from Pier E-5 westward to join the concrete viaduct on Yerba Buena Island.

This cantilever structure with its main span of 1400 feet and two anchor arms of 508 feet is the longest and heaviest of its type in the United States. Although the West Bay suspension spans have been considered more spectacular, the cantilever presented greater difficulties in design, fabrication and erection. Design

In design, nickel steel was used in the main compression members, and in the bottom chords of the suspended span on the cantilever, where rigid members were required for erection. Approximately 3500 tons of this high-strength nickel steel was used, resulting in lighter members and a consequent reduction in dead load and earthquake stresses. Had material of less strength been used, each member would have required either greater depth or greater thickness of material to secure the required area. The greater depth would have increased the secondary stresses; greater web thickness would have increased the grip of rivets beyond the maximum of seven and one-eighth inches for one and one-quarter-inch diameter rivets. Secondary truss members were constructed of silicon steel, as was most of the floor and lateral system.

For the main tension members heat-treated eyebars were used. Details and minor members were constructed of carbon steel. Manganese rivets were used for the heavier joints, and pins were heat-treated chrome nickel steel.

Following are quantities of the various structural steels used in the cantilever structure:

	Tons	*Per cent*
Nickel steel	3,576	17
Heat-treated eyebars and pins	3,465	17
Silicon steel	7,878	39
Carbon steel	5,424	26
Manganese rivets	84	1

These quantities do not include the steel used in the supporting towers.

In developing details of members, closed box members with manhole entrances were used wherever possible instead of laced members, as box members are lighter than laced members, lacing is difficult to maintain and its structural action is somewhat uncertain. Heavy secondary stresses and riveted connections of excessive

Eyebars in Parallel Rows

length were avoided by the use of pins where such large stresses would otherwise occur. Eyebar members of the truss were placed in two parallel rows, one above the other in the plane of the truss. This served the double purpose of reducing the width of the member and, because of increased depth, giving a more substantial appearance.

Upon completion of the Yerba Buena spans the traveler used there erected a second traveler for erection of the cantilever. This second traveler had two 50-ton guy derricks mounted on a mast beam. The masts were 118 feet high and were spaced 44 feet on centers; the booms were 100 feet long and were rigged for main and auxiliary falls and a runner line. Power for operating the traveler was supplied by two 175-horsepower gasoline engines and two auxiliary engines, all of which were placed on the bridge deck and did not move with the traveler. The traveler was supported and moved on skids made of the beams designed to be used later as railway stringers in the suspended span. In lower position, these skids were supported on the upper deck floorbeams which were in turn shored from the lower deck floorbeams. In its elevated position the skids were supported by floorbeams temporarily attached to the truss verticals.

Erection of Traveler

The traveler used in the erection of the Yerba Buena spans had sufficient capacity to erect the members of the suspended span. Therefore when the guy derrick traveler reached the east end of the west cantilever arm, it was dismantled and reerected at Pier E-4 on the east cantilever arm. From this point the traveler worked through to the center of the suspended span. The west half of the suspended span was erected by the Yerba Buena traveler. This procedure saved an additional heavy traveler and inasmuch as the bridge construction schedule was governed by the West Bay crossing, the additional time was not lost.

Erection of Anchor Arms

The anchor arms of the cantilever structure were erected on three falsework bents located at panel points 2, 6 and 8, numbered westerly from Pier E-2. The falsework for the west arm rested on the island. That at Panel 2 was supported on steel piles driven at the shore line; at Panel 6 on concrete bases and at Panel 8 on timber cribs. The falsework for the east arm was supported on timber piles.

Closing of the cantilever was accomplished as follows:

Between the divided legs of Bent E-4, which is the expansion end of the cantilever, were placed two pushing jacks and two pulling jacks, each of 500-ton capacity, hydraulically operated. With these jacks it was possible to push the east half of the structure west or pull it east in order to take up such variation as might occur at the center. Also at each end of the suspended span in the top chords were placed two similar jacks by which the center of the suspended span could be raised or lowered to make proper connection.

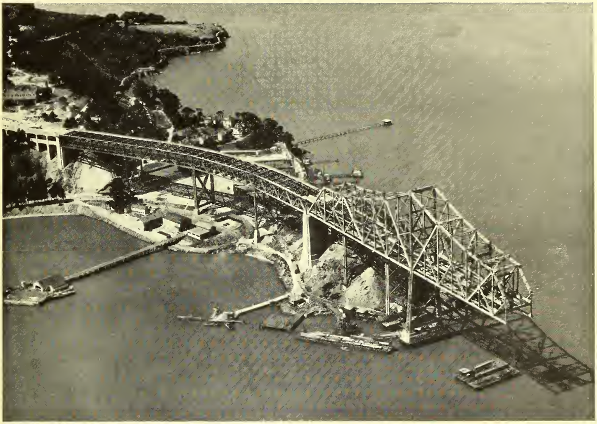
Jacks Close Cantilever

Erection was completed to the center and the span closed on March 25, 1936. Closing operations were completed by the above method very successfully and without difficulty.

The contractor completed riveting and miscellaneous work and moved off the job on June 26, 1936, erecting approximately 20,000 tons during the year.

Paving

At an early stage of the design, it was decided to use a comparatively lightweight floor for the upper deck roadways, and an arbitrary weight limit of 60 pounds per square foot was established. After an investigation of the various types of



Aerial View of the West Cantilever Arm of the East Bay Crossing, September 15, 1935

flooring that would come within this limit, the designers concluded that a light-weight concrete floor would be more economical in first cost and in maintenance than any of the other possibilities.

Paving Materials

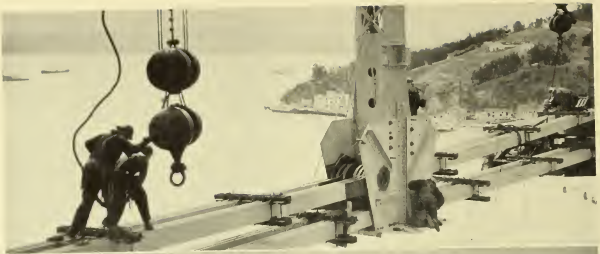
The coarse aggregate consists of a shale which is crushed, pugged, cut into pellets and then burned in a rotary kiln. Fine aggregate consists of approximately 30 per cent natural sand and 70 per cent light-weight sand. When mixed with six sacks of cement, the resulting concrete has a wet weight of 100 pounds per cubic foot and a 28-day strength of 3000 pounds.

Reinforcing Trusses

The roadway slab on the upper deck is six inches thick and is reinforced in both directions. Longitudinal reinforcing consists of one-half-inch rods on six-inch centers. Reinforcing transverse to the bridge centerline consists of welded trusses spaced six to nine inches apart. Top and bottom chords of the trusses are made of two one-half-inch round bars; the truss bracing system is a seven-sixteenths-inch round bar bent to make 45-degree angles between the two chords to which it is welded at each intersection. These welded trusses have an overall depth of four and one-half inches and a length equal to the roadway width. To hold them firmly in place during pouring operations they were welded to the supporting stringers, which are spaced on six-foot centers.

Placing of Upper Deck Slab

The upper roadway slab was placed in two operations. In the first operation the light-weight concrete was placed in the forms, compacted by a vibrator-equipped finishing machine and screeded one-quarter-inch low by the same machine. Before



Closeup View of the Parallel Rows of Eyebars Which First Bridged the Gap in the Cantilever Span

These Eyebars Slipped Across a 60-Foot Gap Successfully Connected the 1400-Foot Cantilever Span on March 24, 1936

Fastening Last Pin Which Aided in Closing the Cantilever on March 26, 1936

the concrete had taken its initial set it was covered by a mortar topping, screeded and belted by the finishing machine. The results with this pavement have been extremely satisfactory in every particular.

Lower Deck Pavement

The lower deck pavement is designed for heavy trucks. The designers considered the light-weight floor somewhat experimental and therefore the lower deck pavement was designed with a six and one-half-inch slab of standard concrete. The reinforcing steel and methods of placing the pavement were as above described for the upper deck, except that the concrete was placed in one course.

Paving was laid from west to east except on the cantilever span, where operations were carried on from the two anchor arms toward the center of the suspended span in order to preserve the correct distribution of load.

Paving Schedules

On July 1, 1935, paving was 42 per cent completed, extending from Span E-22 to Pier E-8 on the lower deck and from Span E-22 to Pier E-9 on the top deck, with two lanes to Pier E-8. No work was done during completion of steelwork from May 28 to June 30, 1935. On July 2 paving was resumed and carried forward to the center of Span E-4, where it was again necessary to stop paving to await completion of the steelwork. Paving was completed to this point on August 8, 1935.

Equipment was then moved from Span E-4 to the east approach mole spans, which would normally have been paved first, but which had not been erected at the time paving operations started. These spans consist of plate girders carrying the upper deck only, from Pier E-23 to Pier E-33, a distance of approximately 830 feet. The grade changes from 2.74 per cent to 4 per cent, and floor stringers run longitudinally instead of transversely, so that a slight change in the method of paving was necessary.

Mole Spans Paved

Paving on the mole spans was started August 27th and completed (including adjacent panels in Span E-22) on September 17, 1935. This completed all possible paving until closure of the cantilever span should give access to the Yerba Buena Island spans.

The contractor utilized the period of waiting to move his plant to Pier E-4, for the work had reached a point 8000 feet from his batching and mixing plant at the mole. The narrow gage industrial railway, used for delivery of dry batches to the mixer, was replaced with a gravel roadway for batch trucks. Three one-cubic-yard trucks were put in service, to operate over the top deck pavement to Span E-4. The steel elevating tower was removed from Span E-22 and remodeled to utilize the steam hoist in connection with a stiffleg derrick on the top deck over Pier E-5.

Paving Equipment

The north half of the upper deck on Span E-4 between panels numbers 6 and 11 was floored over with a one-inch temporary concrete floor on which were placed the old mixer, the new delivery belt and the receiving hopper for concrete. The mixer was powered with a six-cylinder gas engine, replacing the original steam rig; and a ramp and platform were built on the receiving side of the mixer to give the trucks access to the skip. A 2000-gallon elevated water tank was placed opposite the mixer. The narrow gage track and equipment was relaid from Span E-4 to Span YB-1 as soon as the cantilever was sufficiently completed in March, 1936. Forms and reinforcing steel for the first three Yerba Buena spans had been taken to the island by barge, and were in place ready for concrete as soon as the track could be laid.

The first concrete was poured here in the lower deck of Span YB-1 on April 11, 1936. Operations were carried on without delay from this point easterly across the island spans and the cantilever to meet the previous work at the middle of Span E-4. There were no particular difficulties to overcome during the last stage of the work. The lower deck and the center and south lanes of the top deck were completed first; the north lane from YB-1 throughout was left until the last. The entire pavement was completed on June 2, 1936.

Yerba Buena Spans

On this work 175,000 square feet of five-eighths-inch plywood forms were used, with an average use of 5.5 times for each piece. Some of the forms were used ten to fifteen times, but much of the material was used only once, being purchased for use also on the West Bay paving. Approximately 150,000 feet board measure of two-inch by four-inch and of four-inch by four-inch lumber was used for supports. Most of this was also shipped to the West Bay for further use.

Quantities and Costs

Significant distances, quantities, and costs are as follows

Total length of pavement, top deck	11,079 feet
Total concrete, top deck	11,977 cubic yards
Total length of pavement, bottom deck	9,249 feet
Total concrete, bottom deck	6,463 cubic yards
Total cost of pavement, including reinforcing steel, light-weight aggregate and cement	$743,991.57
Average cost per cubic yard	$40.35
Average cost per cubic yard exclusive of reinforcing steel	$21.31
Total marker tiles used	84,150
Approximate cost of tiles used, including equipment	$11,525

Status of Work

As of June 30, 1936, the paving is 99.8 per cent completed. The pavement itself is placed, completed on schedule despite the six and one-half-month waiting period during completion of steel work, but there remain a few items of extra work to be done before the job can be accepted. Work was speeded up during the last period, April to June, 1936, to a maximum of 277 cubic yards a day as against a maximum of 150 cubic yards during the earlier part of the year.

Personnel

The personnel on this contract is identical with that of Contract 6, except that V. A. Endersby is Resident Engineer for the State.

Painting West and East Bay Superstructures

⟦Contract No. 9⟧

Progress July 1, 1935, to June 30, 1936

Status on June 30, 1935

On June 30, 1935, the field painting on the West Bay Crossing stood as follows:

Tower 2—Completed.

Tower 3—Third coat, 15 per cent completed.

On the East Bay Crossing the conditions were:

288-foot spans—Fourth coat 4 per cent completed.

West Bay

The painting of the towers was completed on December 21, 1935. Other work in the West Bay has included the cable paste applied ahead of the cable wrapping for 70 per cent of the west half of the bridge, completion of the first coat and approximately 75 per cent of second, third and fourth coats on suspenders, and 95 per cent of second coat on the steel work west of Pier W-4.

Equipment

The painting of the truss spans was effected in three separate operations. Upper deck and truss steel was painted by spray guns from a special gantry covering the full width of the bridge and traveling on lower deck curbs. Lower deck and truss steel was painted from the inspection bridges using spray guns, as done on gantries, followed in each case by brushing out if required. The balance of the painting comprised insides of chords, painted exclusively with brushes, and curbs, walks, rails, tops of chords, and diagonals painted without special equipment and using either spray guns from portable rigs or brushes as was convenient. Each main group includes about a third of the total work to be done on the span.

East Bay

Schedules

All coats east of Pier E-9 were completed by September 13, 1935, at which time painting of the 504-foot truss spans was started. Painting was completed west of Pier E-5 on December 20, 1935. In the meantime painting of the island spans was started on July 8, 1935, and these spans received their second and third coats by December 14, 1935, on which date all painting work was suspended awaiting further steel erection.

Work was resumed on January 24, 1936, and by June 30, 1936, the second coat on the cantilever was approximately 75 per cent completed. Fourth coat on the Yerba Buena steel bents was 50 per cent completed.

Personnel

This contract is held by Bridge Builders Inc.

Administration Building and Toll Plaza

[[Contract No. 10]]

Progress July 1, 1935, to June 30, 1936

General

The operation of the bridge is a business with an estimated annual income ranging from four to eight million dollars. It will also be essential to maintain the 78 million dollar investment. It was therefore necessary to provide headquarters for the operating and maintenance personnel and to provide adequate facilities for collecting the tolls that will form the main source of revenue.

Design

The Administration Building is 70 feet north and south and 74 feet east and west. Slabs, beams and columns are reinforced concrete. In the basement are located the boiler room, battery room, electric substation, file room, general storage and entrance to the tunnel under the toll booths. Toll sergeant's room, tellers' room with its cash vault and bullet-resisting construction, fully equipped first-aid room, quarters for the State Highway Patrol, main locker room and desk room are located on the first floor. On the second floor are the administrative offices.

Interior Design

Vestibule, main entrance, lobby and main stairway occupy the central portion of the first floor. A private stairway goes from the first floor to the roof with an entrance at the second floor. A concrete record vault with steel door and combination lock is provided in the bookkeeping room. The main indicator and control board, information desk with P.B.X. board, turret board and enunciator system are located in the desk room. Lookout stations and ventilation fan room are provided on the roof.

The single-story section extends westerly 110 feet from the main building and is 63 feet wide, north and south. It houses the garage, fully equipped machine shop with repair pit, maintenance shop, supply room, locker room, toll room and single cell lock-up.

Exterior Design

Side walls and roof of this section are of reinforced concrete supported by structural steel rigid frame in which each beam is rigidly connected to its supporting columns to act as one piece, thus effecting a material saving in steel. Steel purlins between the rigid frames support the roof. Ample light is provided by large windows and skylights.

Toll Booths

Extending southward 218 feet from the Administration Building and across the roadway are the toll booths and canopy. The canopy frame is of structural steel, with subway H columns. It extends to, but not over, the two south truck lanes. Clearance under canopy is 14 feet. The roadway is widened out to 192 feet at this point to provide for 16 lanes of traffic through the toll plaza. The two

Aerial View of Administration Building and Toll Plaza, January 25, 1936

outer lanes at each side of the roadway, four in all, are for trucks and are provided with scales. Autos will be allowed over the scales when necessary; thus providing eight lanes for peak auto traffic in each direction. In one-way peaks twelve lanes may be operated in one direction, four in the opposite.

A tunnel, seven feet by thirteen feet wide, runs under the Toll Plaza from the basement of the Administration Building. It contains all steam pipes, water pipes and electrical conduits for the toll booths, main water, power and telephone lines to the Administration Building, and affords access to scale levers and mechanism.

Gasoline pumps, air and water facilities for servicing automotive equipment, and a 60 by 90 foot parking space is provided outside the west end of the garage. An 85 by 105 foot parking space is provided east of the Administration Building.

Principal Dimensions, Materials and Units

Slab Thicknesses

By careful design and placement of reinforcement, unusually thin concrete sections were obtained. Various concrete slab thicknesses are as follows: roof slabs, three inches; floors, three and one-half inches except under vaults and stationary furniture where they are increased. Garage floors are six and one-half inches, machine and maintenance shop floors, four inches. Walls below first floor level, ten inches. Above first floor level, north wall, eight inches; remaining walls six inches with a three and one-half-inch terracotta facing.

The front steps and floor of the vestibule are of granite laid in cement mortar.

Use of Terra Cotta Blocks

South, east and west walls of the Administration Building and garage are faced with terracotta blocks, 24 inches by 40 inches, three inches thick and colored

to imitate granite. Dovetail projections cast on the back of the blocks in manufacture cause them to be securely fastened to the soft mortar in which they are laid and which in turn forms a strong bond with the concrete wall. The fastening is made doubly secure by loops of heavy Number 6 wire encased in the concrete during construction and linked by quarter-inch pencil rods to other wire loops in the blocks.

Partitions in the garage and in the basement except electric substation walls are of hollow terracotta tile of the usual type for similar construction. They carry no design load and can be taken out or placed elsewhere if desired.

Floors and wainscot in toilets and shower rooms are of glazed ceramic tile of unusual and pleasing color and pattern.

ROOFING

The three-inch concrete roof slabs of the Administration Building, garage and canopy over the toll booths were given a treatment of four layers of 40-pound composition roofing. The first layer was lightly spot-mopped to the clean, dry concrete surface. Each succeeding layer is pasted to the layer beneath it with an even mopping of hot asphalt, 350 to 400 degrees Fahrenheit, and applied 20 pounds to 100 square feet. The last two layers were placed at right angles to the first two. All strips were laid overlapping 19 inches, leaving 17 inches exposed. The resulting thickness is one-half inch. This was reinforced with an additional layer at high points and low points. Roofing was bent up continuously around skylights, parapet walls and pipes. Copper flashing was used also at these points to prevent leakage. The entire roof was finally given a heavy mopping (one-half pound per square foot) of hot asphalt. Clean dry gravel, one-fourth inch to one-half inch in diameter was immediately sprinkled on and embedded in this asphalt.

Roof Thicknesses

LATHING AND PLASTERING

Walls were formed with two rows of three-fourth inch channel studs in full lengths at 12-inch centers with lower ends grouted into place in the floor slab, and upper ends wired to the ceiling furring. They were braced every 30 inches in height with one-inch horizontal channels wired to each stud, and secured by three-fourth inch channel braces or separators every 24 inches in height. Each side of the wall framing was covered by diamond mesh expanded metal lath. Plastering consists of scratch, brown and finish coats to grounds five-eighths of an inch thick over metal lath. Where increased stiffness was required, as in walls to receive Micarta, or where doors came close together, columns were formed by filling sections of the wall solid with cement mortar.

Plaster Qualities

FLOOR COVERINGS

Asphalt tile, 12 inches square, was used on the floors of the toll sergeant's room and desk room. Rubber tile was used in the first aid room, anteroom, public telephone booth, corridor and officers' room. The lobby floor is of terrazzo, with a straight-line pattern of aluminum strips. The remainder of the first floor and the entire second floor is covered with battleship linoleum. Floors of the toll booths are of cork tile.

View Showing East Side of the Administration Building and Toll Plaza, June 28, 1936

WALL COVERINGS

Use of Micarta

Walls of the lobby and stairway are of Micarta panels, two feet eight inches by three feet six inches. The joints are trimmed with stainless steel strips, sprung into a copper clip base so that no fastenings are visible. In the toll sergeant's room and desk room the walls are of Micarta with close butt joints and no metal trim. The color chosen for all Micarta walls was Sahara sand. It is glued to plastered walls with water-resistant glue.

Walls of the tellers', first aid and locker rooms and rear corridor are covered with wall linoleum one-sixteenth of an inch thick. It is washable and makes a satisfactory wall covering in appearance and durability.

The remaining walls of the Administration Building are painted and stippled in approximately the same color as the Micarta. Garage and basement walls and ceilings are painted white with a brownish gray wainscot or dado.

BULLET-RESISTING INSTALLATION

Windows Bullet-proof

Another construction item of unusual interest is the bullet-resisting protection for the tellers' room. Bullet-resisting steel, a high carbon, manganese alloy, is installed in the partitions. This material was also applied to the two doors in the entry. All windows are of bullet-resisting glass. This is a clear plate glass in three layers with clear membranes of cellulose material between. The resulting thickness is one and three-sixteenths inches. Bronze gun ports of bullet-proof construction are set in all doors and windows.

All steel, glass and gun ports are guaranteed effectively to withstand shots from any side arm made including the Thompson sub-machine gun and the entire installation is approved by the Underwriters' Laboratories.

CASH VAULT

Walls and roof of the cash vault in the tellers' room are of concrete, reinforced with three mats of bars. The door is of open-hearth steel and locked with one-fourth inch bolts and a combination lock. A night depository is provided for use when the tellers' room is closed. Vents are provided to prevent suffocation should anyone be locked in the vault.

Night Depository

ACOUSTICAL CEILING TREATMENT

Acoustical ceilings are designed for a 75 per cent noise reduction and were installed throughout both floors of the Administration Building. The sound absorbing medium is rockwool quilts, one inch thick, placed in a horizontal plane between furring channels. They are covered with unbleached muslin. The "stuffing," which looks like the cotton of an ordinary quilt, is in reality spun glass.

Transite Board

Transite board, ceiling surface material is placed below the rockwool, care being taken to keep an air space between them. Transite is a composition board, three-sixteenths of an inch thick, formed under heavy pressure, and containing Portland cement and asbestos. The boards are two feet square with beveled edges, perforated at half-inch spaces both ways with one-eighth inch holes. They are screwed to wooden furring grounds. This installation is fireproof and vermin proof.

DECORATIVE MATERIALS

Extensive application of modern materials of construction to decorative and utilitarian purposes forms an especially interesting construction feature.

Aluminum: Outside doors, handles and push bars; window sash, casings and mullions; cornice, interior and exterior trim; facia and ceiling of the canopy; frames, ceiling, roof, and cabinets of the toll booths. All of the signs, except those having neon tubing, are made of sheet, cast, rolled or extruded shapes of aluminum. These items have all been given the "Alumalite" finish—an electrolytic process in an 18 per cent solution of sulphuric acid whereby the surface is given a hard, permanent silky texture, resistant to corrosion.

Micarta: Composed of laminations of paper, the adhesive and surface material being liquid Bakelite. The whole is compacted under heat and pressure into hard tough sheets having a pleasing appearance of lasting luster. It is waterproof, acid-proof, and fireproof. Used as a wall covering for radiator fronts, window sills, et cetera.

Monel Metal: Nickel 60 per cent, copper 33 per cent, iron one per cent. Used for the bannister and trim of the main stairway, drainboards and sinks.

Stainless Steel: Iron 75 per cent, chromium 17 per cent, nickel eight per cent. All trim around the edges of Micarta in the lobby, toll sergeant's room and desk room is of this metal. Owing to the severe exposure to salt air and vapor corrosion at this location, the use of noncorrosive materials for all work exposed to the air was essential.

Heating and Ventilating

Radiators are concealed in the furring under the windows and in cabinets in the toll booths.

Unit heaters are provided in garage, machine shop, maintenance shop and locker room. They consist essentially of a square box, open front and back, with a fan blowing air across steam pipes with vanes closely packed on them to increase radiation. Unit Heaters

Circulation through the heating system is provided by a vacuum heating pump. It is capable of discharging against a pressure of twenty pounds per square inch and a vacuum of five and one-half inches of mercury.

Oil burners are fully automatic. They are complete with viscosity control, gas-electric ignition, high-low fire control, radio filter and fire safety switch. Bottled gas is used for oil burner ignition. The fuel oil storage tank, twenty-two hundred gallons capacity, is located under the sidewalk near the southwest corner of the Administration Building.

Two fire tube boilers are provided, with 190 square feet of heating surface each. The boiler installation includes a 220-gallon blowoff tank to prevent discharge of hot water or live steam into the drainage system with its consequent damage to the lead-calked pipe joints.

The water heater is of the steam coil storage type. The tank has a capacity of 370 gallons. The heating element is a copper "U" tube and is sufficient to heat 150 gallons of water per hour from 40 degrees to 140 degrees Fahrenheit with steam at zero gage pressure. Water Heater

The entire basement, tellers' room, public telephone booth, all toilets and shower rooms of the Administration Building have exhaust ventilation through ducts to the main exhaust fan in the penthouse. This fan has a capacity of 6030 cubic feet per minute and produces an air velocity of 300 feet per minute at all grilles and 400 feet per minute at all screens in the basement. It is powered by a one-horsepower motor running at 1800 revolutions per minute.

The electric substation, repair pit and machine shop each has its individual exhaust ventilation system, similar to the general system except that they are smaller and discharge individually through the garage roof. All fans are arranged for a "V" belt drive.

Plumbing

Since this project houses so many separate units, some of them self-contained, eight toilets, five kitchenettes and three shower rooms were found necessary. Since there is practically an office building, steam plant, garage and service station combined, and a complete sewer system including outfall needed, a plumbing system comparable to that normally found in a building two or three times the size of this one was required. All soil and waste piping from plumbing fixtures connect to an eight-inch trunk sewer with outfall at the northwest corner of the retaining wall. The lowest point of the building is below tidewater, so drainage from the basement, tunnel and scale pits goes into a sump at the north end of the tunnel. It is pumped from here into the trunk line. Complete drainage is also provided for the roofs, machine shop pit and car wash rack.

View of the Toll Booths Under Construction on June 15, 1936

Scales

Tolls are to be charged for loads carried in trucks. For weighing these loads a 40-ton scale with a 60-foot platform was provided in each of the northerly and southerly lanes and a 30-ton scale with a 30-foot platform in each of the adjoining lanes, making a total of four scales.

Sixty-foot Scale Platforms

All scale platforms are concrete and set flush with adjacent pavement. All pivots and bearings are of self-centering, self-aligning, knife-edge type. No appreciable depression of platform is caused by full load, thus there will be no jar as trucks pass over the scales. Sixty-foot scale platforms allow truck and trailer to be weighed in one operation. Scale dials are marked off in hundred-pound graduations.

Each scale will be equipped to provide an automatically printed weight record to the nearest hundred pounds on tickets, in duplicate, and also on a continuous strip wound up on the inside of the machine under lock and key. Scales are capable of indicating and printing the weight of any load within three seconds after truck comes to a stop on the scale platform.

Kitchen Equipment

Since there will be activity in and around the Administration Building, garage and toll plaza throughout the full twenty-four hours of the day, and because of the isolated location, five kitchenettes have been installed at convenient points to accommodate the various units. Each kitchen cabinet is made entirely of steel, and contains drawers, cupboards and shelves. Hot and cold water, convenience outlet, two-unit electric plate, Monel metal sink and drainboard are all provided.

Electrical Work

This item includes the complete electrical wiring system for light, power, signs, telephone and signal service, installing and connecting motors and control apparatus as follows

Special conduits for primary cables, signal cables and telephone cables.

Wiring for light, power and signal systems.

Electric fixtures and lighting equipment.

Conduits and outlets for telephone system.

Tariff indicators with all necessary relays, motor generator, checking annunciator and cables.

Complete fire alarm system and electric clock system.

Complete intercommunicating telephone system and apparatus.

Neon tubing, transformers, wiring and all apparatus for electric signs.

Warning flashers and reflectors.

For furnishing and wiring of complete electric substation and main control board see Contract No. 11.

Foundations

Foundation material is hydraulic sand fill on soft clay, underlaid by mud, clay and clay sand formations. In some places mud had been forced up to the surface by the weight of the fill and much of the site was under water at high tide. Consequently a sheet pile cofferdam was required for retaining wall excavations. All foundations are spread footings of reinforced concrete supported on wood piling.

PILE DRIVING

Six hundred fifty-one piles were driven varying in length from 90 to 110 feet. A pile driver with leads sufficiently high to drive these long piles would have been practically unmanageable on this soft ground. A skid driver rig with 90-foot leads was used. Each pile was inserted in a hole, 50 feet deep, made with a water jet and the driver moved ahead until the pile came within the leads.

RETAINING WALL

A 12-foot, cantilever type, reinforced concrete retaining wall surrounds the building and parking lots on the north, east and west sides. It is supported on two rows of piles at four-foot centers, the outer row being battered outward four inches per foot to take the outward thrust of the earth behind the wall. False leads were built on the front of the driver, to the proper batter, to drive this row of piles.

WATERPROOFING

Upon the ground surface under the Administration Building, a three-inch concrete slab was placed. This was given a coat of asphalt primer and then a heavy mopping of hot asphalt. It was then covered with four layers of closely woven cotton fabric impregnated with asphalt, and with a heavy mop coat of asphalt between each layer, and on top of the last layer, making five moppings in all. The thick tough waterproof membrane thus formed was continued, unbroken, three feet up around all walls and columns. One inch of concrete was poured on the

Use of Asphalt

membrane to protect it while placing reinforcing steel for the main basement floor slab of reinforced concrete, 11½ inches thick. Membrane around walls and columns is protected by four and one-half inches of concrete.

Retaining walls, outside walls of building, tunnel and scale pits below ground surface are protected by two coats of Inertol. Parapet walls of roof and garage were given one heavy coating of fiber coating and painted with aluminum paint.

Beneath the granite steps and floor of the main entrance, a waterproof membrane consisting of three plies of Pabcoweb and four moppings of asphalt was laid in a manner similar to that of the basement floor.

Equipment

All equipment was of standard type generally used for the various classes of work. No concrete plant was constructed at the job. All concrete was batched at a commercial plant and delivered in transit mix trucks.

Status of Work, June 30, 1936

Major Items Complete	*Started*	*Completed*
Excavation	August 9, 1935	February 29, 1936
Driving timber piles	August 19, 1935	November 1, 1935
Foundation concrete	October 8, 1935	December 6, 1935
Structural concrete	November 4, 1935	May 16, 1936
Concrete railings	May 11, 1936	June 5, 1936
Waterproofing	January 15, 1936	January 25, 1936
Paving base courses	March 16, 1936	April 23, 1936
Flag poles	April 27, 1936	June 19, 1936

Major Items Incomplete	*Started*	*Estimated Completion Date*	*Per Cent Complete*
Truck scales	March 10, 1936	October 23, 1936	50
Administration building, general construction	November 25, 1935	October 21, 1936	94
Toll booths and canopies, general construction	January 27, 1936	October 21, 1936	42
Heating and plumbing	November 18, 1935	October 23, 1936	95
Electrical work	November 18, 1935	October 23, 1936	68

Personnel

The Clinton Construction Company, San Francisco, California, has the general contract. V. A. Endersby is Resident Engineer for the State.

Electrical Work

[[Contract Nos. 11-11A]]

Progress July 1, 1935, to June 30, 1936

General

Recognizing the increasing demand for adequate highway lighting, the sodium vapor installation on this structure represents the latest developments along this line. It was equally essential to provide dependable and adequate navigation and airway signals. The dependability of the system is assured by two independent sources of supply.

Although awarded as a single unit, the contract is made up of two sections, that designated as Contract Number 11, covering the installation on the main bridge, and that designated as Contract Number 11A, covering that on the various approaches in San Francisco and the East Bay. Provisions had been made in the prior contracts for the placing of the necessary conduits in the structure before the pouring of the concrete.

Substations

Electrical energy is supplied by the Pacific Gas and Electric Company at 12,000 volts and is stepped down to 2400/4160 volts (through three 150 KVA, single-phase, 60-cycle, oil-insulated, air-cooled transformers) at two supply stations located in the San Francisco anchorage and the Administration Building. **Supply Stations**

Distribution to the six substations is through a Number 4/0 cable. The phase conductors are laid up in the conventional manner. The ground or neutral conductor, formed of three bare wires, is laid in the interstices of the phase conductors to give a smaller overall diameter under the reinforced rubber jacket. The combined area of the three ground wires is the same as each of the phase wires.

Sectionalizing oil circuit breakers are provided at each end of each substation, manual closing and remote trip except at the east end of the substation at Yerba Buena Island where the breaker is provided with a solenoid operated mechanism for operation from the control board in the Administration Building. Each breaker is provided with an interlocked lockout release so that at least one breaker must be open at all times to prevent tying in the two ends which may or may not be in synchronism. **Breakers**

The overload protection for each pair of breakers is interlocked so that only the breaker immediately back of a fault will open. By tripping the breaker at the other end of the faulty section, the fault is isolated. Closing the solenoid operated breaker then restores energy to the remainder of the circuit.

The main breaker at each point of supply is equipped with undervoltage protection. Failure of potential at either of these points will cause that breaker to drop out, the solenoid operated breaker may then be closed by the operator and energy is restored to the entire line. This provides practically all of the protection of a duplicate system at a much smaller cost.

Grounding of Electrical System

Grounding of this system is provided at each end of each substation through a separate grounding conductor of 500,000 circular mils capacity carried separately to ground and terminating in a 50-foot coil of one-inch copper pipe I. P. S. To this ground are attached all grounding conductors, primary, secondary, system, equipment, and lightning arrester. The requirements of the Railroad Commission of the State of California for grounding could not have been satisfactorily complied with and an exception from their ruling was made on this basis and at their suggestion. This provides satisfactory grounding grid of low resistance and high mechanical strength.

Transformers

The transformers and substation equipment in each substation are supplied from the main bus between the two station breakers which allows them to be connected to either source of supply with a minimum of switching. All connections, whether primary or secondary, are completely enclosed either in conduit or in metal gutters to provide safety from accidental contact or mechanical injury. Associated pieces of equipment are mounted together wherever possible to aid in identification and to prevent faulty operation.

Cables

Type of Installation

Throughout the steel structures the cables are run exposed along the chord members. The assembly is single- or multi-conductor as required, using a high grade of rubber insulation, a reinforced rubber jacket and a bronze interlocked armor. This provides adequate protection against moisture, mechanical injury and corrosion.

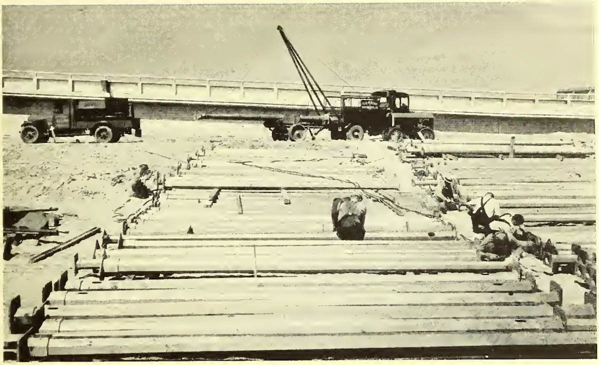
Throughout the concrete structures the cables are carried in conduit and are of the same construction except that a heavy cotton braid is substituted for the bronze armor. This type of installation is also used for the distribution and control circuits on the cantilever and 508-foot spans, where there was no suitable location for the installation of the armored type of cable. All other cables in this location were exposed. For the series lighting cables in conduit a corona shield was provided over the insulation and under the rubber jacket which was of 60 per cent tough rubber compound. A heavy cotton braid is used for the final outer covering.

Control Cable

The control cable, of similar construction, is made up of a central core of seven Number 8 A. W. G. stranded conductors. Over this are placed thirty-six Number 16 wires twisted together to form 12 three-conductor circuits. This forms the smallest size of this cable—43 conductors. For larger sizes, additional layers of single Number 16 wires are added to form 78, 119 and 166 conductors as required. Where these cables are installed off structure an additional layer composed of 16 three-ply impregnated jute is applied and the cables laid directly in a trench without other protection, all cables being laid in the same trench but separated physically as far as possible.

Roadway Lighting Units

Sodium vapor luminaries of 10,000 lumen were selected for this project, after considerable investigation, as it was believed that they offered the most satisfactory roadway illumination. Reflectors are of the parabolic type with auxiliary plane reflectors of a specially polished aluminum anodized to prevent oxidation. These units are mounted 25 feet above roadway to light centers on the upper deck and all roadways at approximately 150 feet centers. On the lower deck the mounting



Welding Bases of Sodium Vapor Luminaire Standards, March 19, 1936

height is 19 feet and the spacing 120 feet except in the tunnel, where the spacing is approximately 70 feet. All units are staggered to alternate circuits numbered odd and even so that a uniform system of half lighting may be obtained by the use of either all odd or all even numbered circuits.

Plan of Illumination

All roadway lighting circuits are remotely controlled from the control board with a series indication for each circuit to indicate when current is actually flowing in each circuit.

The lighting standards are of varying height because of the different base locations. Some are mounted on the chords, some on the concrete rail posts, and some on concrete bases set in the ground. The units are mounted on the top of the standard to a uniform height of 25 feet. The standards are tapered to a 5.5 inch top with a taper of 0.14 inches per foot and are either round or octagonal, as appeared best suited for the location.

Substitution of Mazda Lights

The only exceptions from the sodium vapor type of luminaire was at the Fifth Street Plaza in San Francisco, at the Toll Plaza and at the San Pablo underpass in Oakland, where it was felt that there might be some criticism of this type of lighting because of its lack of color value. At these locations Mazda lighting was substituted.

At the Fifth Street Plaza the units used corresponded to the street lighting units on Fifth Street and are 10,000 lumen, in totally enclosing globes. For the Toll Plaza a somewhat similar type of standard and enclosing globe was used except that the lamps are of 15,000 lumen output and the standards correspond in height to the adjacent roadway standards. The enclosing globes are equipped with an interior reflector to direct practically all of the light into the roadway. The greater intensity was deemed necessary around the Toll Plaza to avoid confusion at the toll booths.

Navigation Lighting

The navigation lighting was designed to meet the requirements of the Department of Commerce for both marine and aviation traffic. Channel lights are provided for five channels in the West Bay and for four channels in the East Bay. These consist of a green light below the chord and three white lamps above each enclosed in a Fresnel lens as required.

Aerial Beacons

Pier lights had been provided under other contracts as these piers constituted an obstruction as soon as construction was commenced and as such must be so marked. Provisions are included under this contract for permanent connections and indications

Revolving aviation beacons are to be installed on each of the six towers. These are 24-inch, 1000 watt, with red lens and Zenith panel revolving at the rate of six revolutions per minute. Those in the West Bay are to have their beams synchronized to point in a common direction, as are those in the East Bay. These two groups are not synchronized together.

Flashing code beacons are to be installed on each of the five 508-foot spans, on a pedestal at the top of the truss at the center of the span. They are to flash together three seconds on and two seconds off.

Status of Work June 30, 1936

The contract for this work was executed on July 12, 1935. The contractor commenced operations on August 9th, building his office and storeroom and preparing for the placing of conduit and cables. The work progressed very slowly for the balance of 1935, only 10 per cent of the work being completed by the end of the year. Since the first of the year the work has proceeded at a more rapid rate, 55 per cent of the work being completed on June 30, 1936, and there seems no doubt that this installation will be ready for the scheduled bridge opening.

Equipment

This work has not required any outstanding equipment. The principal item is a heavy truck equipped with a stiffleg derrick and a winch driven from a power take-off. This has provided a satisfactory rig for the handling of heavy materials, setting poles, pulling wire or cable.

Personnel

The work under this contract is being performed by a copartnership of the Alta Electric and Mechanical Company and the American Building and Maintenance Company of San Francisco. Thomas Bennett has been in charge of the work for the contractor, with Charles Lane as Field Superintendent. H. M. Tilson is Resident Engineer for the State.

San Francisco Section and Approaches

⟦Contract Nos. 15-15A⟧

Progress July 1, 1935, to June 30, 1936

General

As of June 30, 1935, Contracts Nos. 15–15A, covering the main approach to Fifth Street in San Francisco, and the "On" and "Off" ramps connecting with the bridge at the top of Rincon Hill, had barely been started. Up to this date the cellular construction near Fifth Street had been completed, as well as 25 per cent of the foundations.

During the fiscal year ending June 30, 1936, the sequence of building falsework and forms, pouring the girders and the roadway slabs, and finally the railings, went forward at such a steady pace that completion of these approaches for traffic by the time the other parts of the bridge are completed is assured.

The work during the year has included the construction of 42 concrete frames, with an average span of 70 feet, extending from the cellular structure to the top of Rincon Hill. The similar work on the "On" ramp has included 21 concrete spans, complete with paving and railings. On the "Off" ramp 14 such spans have been constructed.

In this work the same high strength of concrete that has been used throughout the project has been maintained. Especial care has been given to the lines and surfaces of the concrete. Plywood forms carefully braced have been used for all exposed surfaces. All concrete was batched at the contractor's plant near the San Francisco anchorage, brought to the work in trucks, raised by hoist to the elevation of the bridge deck, distributed by buggies and vibrated into the forms. All paving slabs have been cured by the impervious membrane process. High-Strength Concrete

Regrading

This contract included the regrading of Harrison and Essex Streets and a large amount of excavation on top of Rincon Hill to the grade of the lower deck roadways. This excavation was composed of shale and sandstone, and provided excellent material for the high fill supporting the "On" ramp west of the anchorage.

Personnel

Personnel on this contract is the same as given above for Contract No. 3.

⟦*For Contract 15A–64TC24 see also "Legislative Approaches."*⟧

Aerial View of San Francisco Approaches on May 15, 1936, Showing the Fifth Street Plaza

[Contract No. 15]

Status of Work June 30, 1936

Demolitions	95 per cent
Excavation-General	33,500 cubic yards
Excavation-Structural	12,700 cubic yards
Concrete piling	16,971 lineal feet
Reinforcing steel placed	4,040,000 pounds
Concrete poured	24,287 cubic yards
Miscellaneous work	65 per cent
Percentage of project completed	88 per cent

[Contract No. 15A]

Demolitions	90 per cent
Excavation-General	197,000 cubic yards
Excavation-Structural	4,480 cubic yards
Concrete piling	4,063 lineal feet
Reinforcing steel placed	1,340,000 pounds
Concrete poured	7,931 cubic yards
Paving	5 per cent
Miscellaneous work	58 per cent
Percentage of project completed	61 per cent

Legislative Approaches

Progress July 1, 1935, to June 30, 1936

One of the conditions of the Reconstruction Finance Corporation loan for the construction of the bridge was that the State would make available funds in the amount of $6,600,000 for the construction of the approaches. The agreement further designated the location of these approaches. In San Francisco the approaches included the Fifth Street Plaza and the cellular structure just east thereof, the "On" ramp leading from Fremont and Harrison Streets to the upper deck, the "Off" ramp leading from the upper deck of the bridge to First and Clementina Streets, and the truck ramp from the top of Rincon Hill to the corner of Folsom and Essex Streets, as well as the necessary regrading of Harrison and Essex Streets. In the East Bay these approaches included the fill from the east end of the bridge to the west side of the Southern Pacific tracks, extending northward to Ashby Avenue, the distribution structure over the Southern Pacific, Key System and Santa Fe tracks, the San Pablo underpass to the terminal at Market Street, the Cypress Avenue line extending to Seventh Street, and the Folger Avenue underpass, with its extension to Ninth Street and Ashby Avenue in Berkeley. Location

The legislative approaches are under the supervision of District IV, Division of Highways, Jno. H. Skeggs, District Engineer, with P. O. Harding in charge.

As of June 30, 1935, the fill from the east end of the bridge to the Folger Avenue underpass, together with its rock wall, had been completed. The East Bay distribution structure had been started. The Folger Avenue underpass was under way.

The progress on each of these legislative approach contracts during the fiscal year has been as follows:

Electrical Work on Approaches (Contract No. 11A)

This contract, which covers the lighting of the approaches, has been described in connection with the corresponding contract on the bridge.

East Bay Approaches

Folger Avenue Underpass (Contract No. 64TC29)

The Folger Avenue underpass was constructed to avoid a grade crossing with the Southern Pacific tracks on the connection between the East Shore Highway and Ashby Avenue. This structure was built to provide for four traffic lanes, the two lanes in each direction being separated by a center pier. The roadways are 21 feet between curbs in each direction. Two sidewalks four feet six inches wide are also provided. Subway Excavated

Both the design and construction of this underpass were controlled by the necessity of building the structure without interruption to the Southern Pacific rail traffic. Accordingly the first step in construction was the construction of a timber trestle on which the tracks of the Southern Pacific were supported. Then the excavation for the subway was completed, using power shovels except for final

trimming of the subgrade. To keep the dirt and earth from the heavily reinforced base slab, a 6-inch layer of concrete was placed on the subgrade, and then the two abutments and center pier of the structure were built.

In the meantime, in a nearby yard, the slabs which were to form the roof of the underpass and carry the tracks of the railway were being cast. Each track is supported by two slabs for each of the two spans, the slabs being six feet six inches wide and 26 feet long, two feet ten inches in depth, and weighing 36 tons. These were placed in position by locomotive crane and waterproofed with membrane similar to composition roofing. This membrane was protected with creosoted planks over which the ballast, the ties and rails forming the standard track construction were placed.

The contractor started work on this structure on June 8, 1935, and completed the work November 30th.

Personnel

The contract for this work was held by J. F. Knapp Company, of which Otto Parlier is associate and superintendent. V. A. Endersby was Resident Engineer.

Distribution Structure (Contract No. 64TC26–84TC1)

Status of Contract, June 30, 1935

The only work which had been done on this contract at the end of the last fiscal year was the construction of 32 out of the 200 bent footings required. At this site foundation conditions were quite varied, with the result that while for most of the piers it was possible to reach a satisfactory sandy clay at a moderate depth, piles were required for 31 of the foundations. The softest material was on

Average Pile Length, 45′

the northerly part of the structure and west of the Southern Pacific tracks. The length of piles used averaged 45 feet and came to practical refusal. In most of the piers east of the Southern Pacific tracks it was possible to do all excavation without cofferdams and practically no ground water was encountered. West of the Southern Pacific tracks cofferdams were required and in general were constructed of 3-inch by 12-inch sheeting braced by 12-inch by 12-inch wales and struts. Also, in the west end of the structure pumping was required, while east of the Southern Pacific tracks only small amounts of water were encountered.

CONCRETE

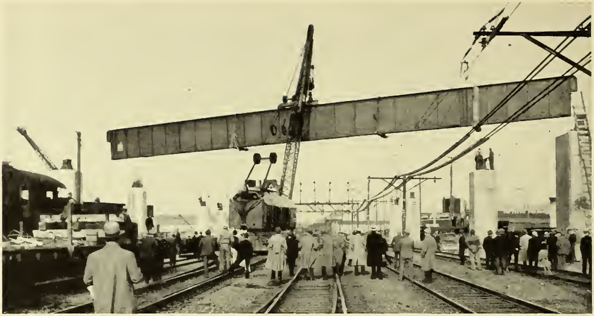
The concrete operations consisted of the usual successive steps of building the footings, the bent columns, and the concrete girders. The contractor reduced the amount of falsework required for these girders to a minimum by erecting timber bents on the footings, which bents in turn supported steel I-beams, which in turn supported the girder forms. These steel supports were moved from span to span as the work progressed. Forms for all exposed surfaces were made of five-eighths inch plywood panels in sections, so that they might be promptly handled for reuse. Concrete was delivered to the job by transit mix trucks, being mixed en route.

Use Transit Mix Trucks

Electric vibrators were used to compact the concrete. This procedure, in combination with the plywood forms, produced a pleasing surface finish.

The construction of the reinforced concrete girder spans was started in August, 1935, and completed early in March, 1936. Placing the concrete slab on the steel spans started during September of 1935 and was completed in March of 1936.

Aerial View of East Bay Distribution Structure Looking North Along the East Shore Highway, May 15, 1936



Erection for the East Bay Distribution Structure of One of the Three Longest Plate Girders Ever Fabricated, December 6, 1935

STEEL SPANS

Inasmuch as the crossings over the tracks of the three railroads had to be performed without interruption to train operations, the use of falsework to support structures over these tracks was impracticable. The design, therefore, provided for steel spans which could be erected between trains. The crossing over the Southern Pacific main line tracks required through plate girders 10 feet deep, 148 feet long. These girders were erected with a locomotive crane of 100-ton capacity. The shorter spans were erected by a crawler crane. The erection of the steel spans was started in August, 1935, and completed in December of the same year.

PAINTING AND SANDBLASTING

The specifications required the usual State procedure of sandblasting rust and mill scale before application of paint. The contractor elected to do this after the spans were erected. Sandblasting was immediately followed by the red lead primer coat. Sandblasting and first coat painting were started in January of 1936 and completed in May. The application of the second and third field coats was started in February of 1936 and is practically completed. Paint was applied with spray guns and brushed out by hand, except that over the Southern Pacific main line tracks paint was all applied by brush so as to avoid spray dropping on Southern Pacific equipment passing underneath.

This entire contract was 98 per cent completed on June 30, 1936.

PERSONNEL

The contract for this work is held by Barrett & Hilp of San Francisco, with J. L. Connelly as Construction Engineer. V. A. Endersby is Resident Engineer.

San Pablo Underpass (Contract No. 84TC3)

That section of the East Bay approaches which is between the east end of the distribution structure and Market Street crosses three important thoroughfares: Peralta Street, Adeline Street and San Pablo Avenue, the latter being the most important of the three. The traffic on these streets is so heavy that from the first it was evident that a grade separation would be required. Preliminary designs, estimates, and a survey of design conditions were made both on the basis of an overhead structure and an underpass. The underpass was selected as being slightly more economical, involving no long span construction, and having no piers to obstruct vision on the surface streets. This project also involves the construction of side streets either side of the underpass so as to provide free flow of circulation at the street level.

GENERAL DESCRIPTION OF PROJECT

The overall length of this project is 0.51 mile, and includes the construction of a reinforced concrete underpass 0.37 mile in length, with the grading and paving of the side and end roads connection to the existing streets. The underpass is a reinforced concrete structure with rigid frame box sections for the San Pablo Avenue, Adeline and Peralta Street crossings, and slab and retaining wall sections for the remaining parts. The structure will be finished with a concrete handrail on the top of the wall sections above the level of the side roads and the street intersections. The side road and street intersections are to be paved with asphalt concrete, placed on a subgrade of selected base material. The main highway from the end of the underpass to the Thirty-eighth Street intersection is to be paved with concrete.

Asphalt Concrete Paving

FOUNDATION CONDITIONS

The ground consists of firm clay and stratified clayish sands overlaid with a layer of black adobe approximately three feet thick. The material is very stable and will stand in a nearly vertical cut except in wet weather. The excavation at the deepest portions encountered water-bearing clay-gravel.

Ground water is present in the material and varies in quantity with the season.

EXCAVATION AND BACKFILL

One cubic yard gas and air shovels were used for excavating to within about 18 inches of the finished grade. The excavation was completed with a three-fourths cubic yard clamshell crane supplemented by hand labor. The excavated material was hauled from the cut to the dump in four and six cubic yard dump trucks. Roadway excavation was made with a shovel and a tractor-drawn scraper for final grading.

The sides of the cut were trimmed to a one-half to one slope to prevent sluffing. No cofferdams or shoring were found necessary to retain the cut. Backfill against the underpass walls was compacted with air tampers to about one foot above the footing slab. The remaining backfill was compacted with tractor-drawn sheepfoot rollers and eight or twelve ton three-wheel rollers. The material was delivered in dump trucks and spread in layers with a caterpillar bulldozer.

Back-fill Compacted

Aerial View of the Distribution Structure Looking Toward Residential Oakland Showing San Pablo Avenue Underpass, May 15, 1936

FORMS AND FALSEWORK

Five-eighths inch plywood panels were used for all exposed concrete surfaces. For the exposed faces of wall sections the plywood panels were backed up by one inch by six inch sheeting on twelve inch centers nailed to two inch by four inch studding on one foot four inch centers. The wales were two inch by six inch timbers on two foot eight inch centers and the forms held rigid by three-fourths inch round tie rods spaced on two foot eight inch centers both ways.

For the roof of the rigid frame sections eight inch by eight inch posts with six inch by eight inch caps and twelve inch by twelve inch stringers carried the two inch by twelve inch floor joists on sixteen inch centers and the sheeting backing up the plywood panels. Roof Dimensions

The forms for the handrail were a combination of steel and metal lined forms held rigid by tie rods.

CONCRETE

The design of the concrete mixes was carried out by the Division of Highways Testing Laboratory, in cooperation with the Bay Bridge engineers, who have direct control of the field placing. The Transit Mix Corporation, Inc., supplied the concrete, batching it at their Peralta Street plant and mixing it en route to the job. On delivery to the site the concrete was discharged into hoppers and buggied to the forms, where it was placed through elephant trunk chutes. Electric vibrators of the flexible shaft type were used to compact the concrete placed in the forms. Discharging of Concrete

The cement content of the mixes was varied from 5.0 to 5.6 sacks per cubic yard, with a constant water-cement ratio of 0.85 by volume. To facilitate placing, six-sack concrete was used in the handrail. With these mixes an average compressive strength of approximately 4000 pounds per square inch is obtained at the age of 28 days.

With the use of plywood forms, vibrators for compacting the concrete, and the control for the concrete mixes, the finished appearance of the concrete in this structure is well above the average.

CONSTRUCTION PROBLEMS

The principal construction problem presented by this structure was the building of the underpass across three heavily traveled streets and at the same time maintaining traffic on these streets. This was accomplished by constructing each crossing as an individual unit, closing all or part of the street to traffic during the working period and diverting traffic over the remaining streets to be crossed. The limited time for construction required the contractor to carry on all parts of the project while constructing the street crossings. The work was carried on during the rainy season, which increased the difficulties of construction. Construction During Traffic

PROGRESS AND STATUS OF WORK

The contract was awarded at the price of $359,932.00. Work started on October 25, 1935. Status of the contract by June 30, 1936, follows:

Excavation for the underpass was completed; roadway excavation was 80 per cent completed; all concrete in the underpass was poured except for the east half of the San Pablo Avenue crossing; sidewalks, parking strips, curbs and gutters along

side roads were 75 per cent completed. Selected base material was placed on part of the side roads, with paving scheduled to start early in July. The contract is scheduled for completion by September 1, 1936.

PERSONNEL

The contract for this work is held by J. F. Knapp of Oakland, California, of which Otto Parlier is Associate and Superintendent. V. A. Endersby is Resident Engineer.

Mole Paving (Contract No. 84TC4)

This contract covers the paving of the mole fill, extending from the east end of the bridge to the distribution structure and thence extending north to the west end of the Folger Avenue underpass. East of the toll plaza the cross-section has a 60-foot pavement to accommodate traffic from the upper deck of the bridge, and two 22-foot pavements, one on either side of the roadway, separated from the main roadway by curbed parkways five and one-half feet in width. East of the toll plaza the present contract includes two 32-foot asphalt concrete pavements, separated by a five and one-half-foot curbed parkway strip in the center. Space is provided for future widening of these pavements when necessary. Between the distribution structure and the Folger Avenue underpass to the north, there are two 21-foot asphalt concrete, one-way pavements, separated by a center parkway six feet in width.

Sixty-foot Pavement

Ten-foot wide rock shoulders, oil treated, are to be provided adjacent to all outside lanes of all the roadways involved.

Work started on this contract in November of 1935, and was 55 per cent completed on June 30, 1936.

PERSONNEL

The contract for this work is held by the Hanrahan-Wilcox Corporation. E. G. Poss is District Construction Engineer with L. G. Marshall as Resident Engineer.

Ashby Avenue Connection (Contract No. 84TC8)

This project involves the construction of a concrete pavement 47 feet wide and 56 feet wide between concrete curbs with eight-foot sidewalk spaces on either side, extending from the east end of the Folger Avenue underpass to a connection with Ashby Avenue at Ninth Street in Berkeley—a total length of 0.3 mile.

Work started on this contract in May of 1936, and was approximately 35 per cent completed on June 30, 1936.

The contract is held by L. C. Seidel. E. G. Poss is District Construction Engineer with L. G. Marshall as Resident Engineer.

Cypress Street Improvement (Contract 84TC10)

This project covered paving from the southerly approach to the distribution structure at Thirty-fourth Street to the intersection of Seventh and Cypress Streets in Oakland, a distance of 1.4 miles. Beween Thirty-fourth and Eighteenth Streets the paving involves an asphalt concrete surface 40 feet in width, two eight-foot oiled and screened rock borders. Between Eighteenth and Seventh Streets the asphalt concrete pavement is 60 feet in width, with eight-foot Portland cement concrete gutters and curbs on either side, providing a completed 76-foot roadway between curbs.

Bids for this work were taken on June 24, 1936, the low bid being that of the Hanrahan Company. The contract has been awarded to that company, and it is expected that the work will be completed in November. Work is to be under the direction of E. G. Poss, District Construction Engineer with F. W. Montell as Resident Engineer.

San Francisco Approaches

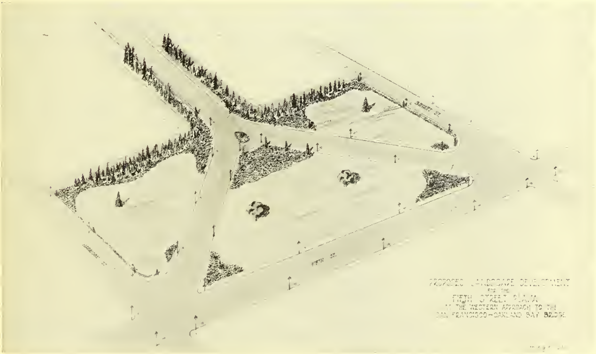
San Francisco Approaches (Contract No. 15A)

The work under Contract No. 15A, San Francisco approaches, has been described on page 51.

San Francisco Plaza Landscaping (Contract No. 84TC9)

This contract includes the nursery development of more than 1100 shrubs and trees, the planting of 64,000 square feet of lawn, and installation of a sprinkler system for the maintenance.

Bids were received on this work on June 3, 1936, the low bidder being the California Nursery Company, to whom the contract has been awarded. Actual planting is scheduled for October. The contract provides for a six months period of maintenance and development, starting in November, 1936. H. D. Bowers, Landscape Engineer, and H. W. Miller, Resident Engineer.



Other Easterly Highway Approaches

Other work which has been done in part to afford better access to the bridge includes the construction of the American Canyon cutoff between Carquinez Bridge and Cordelia, reducing by over six miles the distance to Sacramento; and reconstructing the present highway between the east end of the Broadway low level tunnel to Walnut Creek, providing much better facilities to Martinez, Pittsburg and Stockton.

Additional East Bay Highway Improvements Completed Prior to June 30, 1935

Widening, and Removing Street Car Tracks on San Pablo Avenue from Thirty-eighth Street extending northerly through Emeryville, Oakland, Albany and El Cerrito, a distance of 6.8 miles (Contracts Nos. 64TC5 and 64TC10).

Relocation, Paving and Grading of State Highway Route 14 from San Pablo Avenue to the Carquinez Bridge, a distance of 10.5 miles (Contracts Nos. 44EC7 and 64TC3).

Moss Avenue Extension (Contract No. 64TC31). A project is under way to extend the central legislative approach from its terminal at Thirty-eighth and Market Streets to Grand Avenue in Oakland. On February 7, 1936, this project was completed as far as Broadway in Oakland, which gives access to the Broadway low level tunnel, Walnut Creek and valley points east.

Extension of East Shore Highway from the Folger Avenue connection northward, connecting with San Pablo Avenue at El Cerrito. This affords a route that will by-pass all congested territories in Berkeley and Albany. The first contract, 84WC1–84WMC1, involved the construction of a dredger fill from Folger Avenue to Camelia Street, Berkeley, a distance of two miles. This project was completed April 30, 1936.

Overhead Grade Separation with Industrial and main line tracks of the Southern Pacific in the city of Berkeley (Contract No. 814PGWC1). This work is scheduled for completion in September, 1936.

Surfacing of the Fill from Folger Avenue to Camelia Street (Contract No. 84WC4–64WC7). This work is scheduled for completion in November, 1936.

Grading and Paving of a Four-Lane Highway completing the route from Camelia Street and San Pablo Avenue in El Cerrito, a distance of 3.09 miles (Contract No. 84PWC2–84WMC4). It is anticipated that this work will be completed to El Cerrito by January, 1937.

Other Westerly Approaches

In addition to the "legislative approaches" there is an extensive program of highway improvements which will improve the facilities for traffic to and from the bridge.

Widening and Resurfacing of Fifth Street between Harrison and Bryant Streets (Contract No. 64TC28). This work is adjacent to and forms a part of the San Francisco Fifth Street Plaza, and included the removal of the Market Street Railway Company's double tracks. This work was completed in November, 1935.

Widening and Resurfacing of Bryant Street from Fifth Street to Tenth Street (Contract No. 64TC14). The curbs were set back, giving a roadway width of 66.5 feet between curbs. The work was completed in August, 1935.

Widening and Resurfacing of Harrison Street, Fifth Street to Tenth Street (Contract No. 64TC22). This work was completed in July of 1935.

Widening and Resurfacing Tenth Street and Fell Street from Byrant Street to Van Ness Avenue.

Bridge Railway

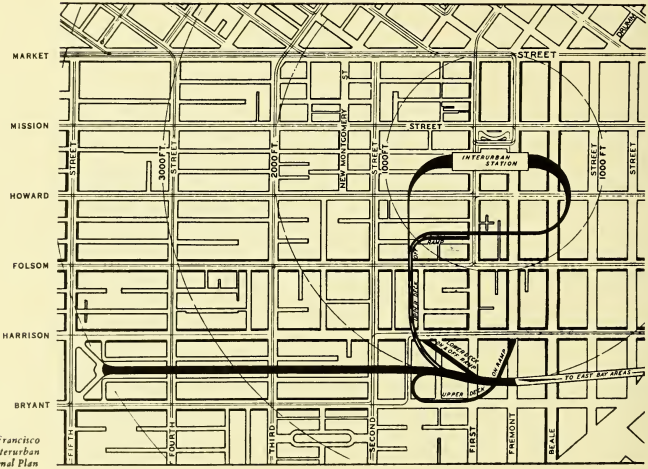
No single feature in connection with the bridge has received as much popular attention as the bridge railway, which will bring the trains of the Key System and the Southern Pacific across the bridge into a terminal at San Francisco. The major part of this interest has centered about the location of the San Francisco terminal. The details of the agreements between the California Toll Bridge Authority and the two railroads have also been studied at length by boards of supervisors, city councils, and various civic organizations on both sides of the bay.

The history of the bridge railway was discussed at some length in the Second Annual Report, bringing it to the close of the fiscal year July 1, 1935, at which time the principal provisions of the contracts between the California Toll Bridge Authority and the railway companies had been agreed to by all parties concerned.

On September 4, 1935, the Authority adopted the Plan "X" terminal located between Beale and Second Streets, Mission and Howard Streets. Meanwhile, conferences were being held between State attorneys, representatives of the various city officials, and representatives of the civic organizations, and during February letters from practically all these organizations were sent the Toll Bridge Authority approving the drafts of the contracts between the Toll Bridge Authority and the two railroads, requesting that these contracts be approved and the facilities be put into operation as soon as practicable. The contracts were approved by the Toll Bridge Authority on February 18, 1936. Contracts were executed on March 6, 1936. In March, 1936, the California Railroad Commission resumed hearings on the matter and approved the contracts on March 23, 1936.

Contracts Approved

Architect's Drawing of the Proposed San Francisco Interurban Terminal



San Francisco Interurban Terminal Plan

These contracts were then forwarded to the Reconstruction Finance Corporation and negotiations were started with that body for funds for the interurban. It is anticipated that these funds will soon be made available, and that the construction of these railway facilities will get under way.

Future Bridge Contracts

No work has as yet been done on the following contracts:

Contract No. 12 will provide for traffic signs on the main bridge; Contract No. 12A, for traffic signs on the approaches. The work under this contract will be performed by Highway District IV.

Contract No. 13, tile lining of Yerba Buena Tunnel. Specifications have been prepared for lining the roof of the Yerba Buena Tunnel over the upper deck with a white tile. Bids are to be received on this contract July 8, 1936.

Contract No. 14, Yerba Buena Garage. Plans and specifications have been prepared for a garage to be located on Yerba Buena Island east of the tunnel and north of the bridge, to house fire truck and two tow trucks. Bids are to be received on this contract on August 12, 1936.

Contract No. 16 covers the operating equipment on the bridge, including toll registers and appurtenances, automotive service equipment, etc. Detailed description of this equipment will be given in a subsequent report.

Contract No. 17 covers the fencing of the bridge right of way on Yerba Buena Island and also sentry booths on the island roads near the bridge. Proposals for these fences are now being discussed with the Commandant of the Twelfth Naval District.

Contract No. 18 includes a sprinkler system in Harbor Piers 24 and 26. These piers are of timber construction and are located under the span one-two of the West Bay crossing. The lowest steelwork of the bridge is 100 feet above these piers, and it is improbable that any fire in these piers would have any effect on this bridge steelwork. However, in order to further reduce this small hazard, we propose to install an automatic sprinkler system in both of these piers. Bids on this work will be received July 29, 1936.

CONTRACT PAYMENTS AS OF JUNE 30, 1936

Completed to Date			Total	To Complete	Total of Contracts
No.	Contract	E.W.O.			
2	$7,398,623	$76,136	$7,474,759	....	$7,474,759
3	1,028,046	19,168	1,047,214	$62,392	1,109,606
4	4,475,815	104,375	4,580,190	....	4,580,190
5	1,965,619	354,773	2,320,392	111,165	2,431,557
6	12,971,216	152,788	13,124,004	1,352,951	14,476,955
7	9,053,621	145,447	9,199,068	20,235	9,219,303
8	255,770	7,401	263,171	....	263,171
9	444,273	5,270	449,543	393,262	842,805
10	269,374	1,405	270,779	91,171	361,950
11	148,795	1,335	150,130	310,391	460,521
15	679,807	1,265	681,072	48,528	729,600
Total	$38,690,959	$869,363	$39,560,322	$2,390,095	$41,950,417

Original Contracts as Let		$39,421,637
Provided for Contingencies	$2,528,780	
Other Work Through Contingencies	471,220	3,000,000
Estimated Total of Contracts as Above		$42,421,637

ESTIMATED COST OF CONTRACTS TO BE LET

Contract No.		
12	Traffic Signs	$3,000.00
13	Tunnel Lining	60,000.00
14	Island Garage	16,000.00
16	Operating Equipment	110,000.00
17	Island Fences	11,000.00
18	Fireproofing Outside Hazards	130,000.00
	Harbor Pier 24	50,000.00
	Total	$380,000.00

STATUS OF RIGHT OF WAY DEEDS ON JULY 1, 1936

	LINE	Total Number of Deeds	Deeds Executed: No.	NET COST (Not including rental credits nor cost of title reports, insurance, engineering, legal expenses, contingencies, etc.) Land	Imprs., etc.	Total
Bridge	Original Line	60	58	$758,313.95	$531,624.05	$1,289,938.00
	Stillman St. Change	47	45	397,537.00	339,810.91	737,347.91
	Total	107	103	$1,155,850.95	$871,434.96	$2,027,285.91
S. F. Bridge Approaches	5th St. Approach	11	11	$222,193.75	$174,890.14	$397,083.89
	"On" Ramp	8	7	98,607.50	26,315.00	124,922.50
	"Off" Ramp	34	30	170,310.80	319,501.76	489,812.56
	Account of Regrade	18	8	38,175.00	41,133.53	79,308.53
	Total	71	56	$529,287.05	$561,840.43	$1,091,127.48
Alameda Bridge Approaches	Cypress St.	89	82	$174,811.70	$124,756.61	$299,568.31
	38th St.	90	88	217,875.16	184,843.91	402,719.07
	Ashby Ave.	43	36	90,904.13	26,739.21	117,643.34
	Total	222	206	$483,590.99	$336,339.73	$819,930.72
	Grand Totals	400	365	$2,168,728.99	$1,769,615.12	$3,938,344.11

SAN FRANCISCO-OAKLAND BAY BRIDGE

CONSOLIDATED STATEMENT OF RECEIPTS AND EXPENDITURES

FROM SEPTEMBER 14, 1932, TO JUNE 30, 1936

RECEIPTS			
Bonds sold to R.F.C.			
June 12, 1933	$2,000,000.00		
September 8, 1933	2,000,000.00		
November 21, 1933	2,000,000.00		
January 20, 1934	3,000,000.00		
March 19, 1934	3,000,000.00		
June 5, 1934	3,000,000.00		
August 22, 1934	4,000,000.00		
November 9, 1934	3,000,000.00		
December 27, 1934	3,000,000.00		
March 25, 1935	3,000,000.00		
June 5, 1935	3,000,000.00		
August 5, 1935	3,000,000.00		
November 5, 1935	3,000,000.00		
January 7, 1936	3,000,000.00		
March 5, 1936	3,000,000.00		
May 6, 1936	3,000,000.00		
			$46,000,000.00
Transfer from State, Chapter 400			10,803.39
Interest from Banks			50,454.28
Rents from Property Acquired			6,074.60
Accrued Interest			27,105.98
			$46,094,438.25
EXPENDITURES			
Engineering Design		$384,105.83	
Triangulation and Survey		215,576.70	
Launch Operations, including cost of Boats and Radio Phones		115,265.54	
Administration, including San Francisco Office Rent, 'Phone, Clerical and Accounting Staff, Progress and Traffic Studies		408,145.12	$1,123,093.19
Consulting Engineers and Consulting Architects			448,730.24
Insurance			412,500.00
Legal			125,467.10
Property, Right of Way, San Francisco Approach and Interurban			2,472,813.89
Rental of Pier 24			77,083.21
Moving Cables—West Bay			92,670.47
Inspection of Steel, Concrete and Materials, all Contracts			337,708.65
Contract 2—Substructure—West Bay Crossing			
Contract Pay Estimates		$7,474,759.14	
Engr. Supervision and Expense		107,780.11	
Diving Operations		19,089.89	7,601,629.14
Contract 3—San Francisco Anchorage			
Contract Pay Estimates		941,916.50	
Engr. Supervision and Expense		52,688.99	994,605.49
Contract 4—Substructure East Bay Crossing			
Contract Pay Estimates		4,580,189.88	
Engr. Supervision and Expense		67,441.39	
Diving Operations		23,320.33	4,670,951.60
Contract 5—Yerba Buena Island Crossing			
Contract Pay Estimates		2,088,387.86	
Engr. Supervision and Expense		102,557.70	2,190,945.56
Contract 6—Superstructure West Bay Crossing			
Contract Pay Estimates		11,815,698.05	
Engr. Supervision and Expense		167,295.20	11,982,993.25
Contract 7—Superstructure East Bay Crossing			
Contract Pay Estimates		8,279,160.97	
Engr. Supervision and Expense		146,942.77	
Diving Operations		1,040.00	8,427,143.74
Contract 8—Girder Spans on Mole			
Contract Pay Estimates		263,170.95	
Engr. Supervision and Expense		35,860.43	
Diving Operations		231.65	299,263.03
Contract 9—Final Field Painting			
Contract Pay Estimates		404,589.11	
Engr. Supervision and Expense		22,205.21	426,794.32
Contract 10—Administration Building			
Contract Pay Estimates		243,701.20	
Engr. Supervision and Expense		32,978.68	276,679.88
Contract 11—Electric Contract			
Contract Pay Estimates		139,561.01	
Engr. Supervision and Expense		17,996.68	157,557.69
Contract 13—Tunnel Lining—Material			18.80
Contract 14—Island Garage—Supervision			183.88
Contract 15—San Francisco Section			
Contract Pay Estimates		612,994.27	
Engr. Supervision and Expense		34,120.40	647,114.67
Contract 16—Operating Equipment—Material			4.38
Contract 18—Fireproofing Outside Hazards			17.36
Interest and Discount on Bonds			4,110,845.04
Coupon Deposit for Interest			605,125.00
			$47,481,939.58
Balance with State Treasurer—Over Draft			—1,387,501.33
			$46,094,438.25

STATE OF CALIFORNIA

DEPARTMENT OF PUBLIC WORKS—DIVISION OF HIGHWAYS

STATUS OF WORK ON LEGISLATIVE APPROACHES TO SAN FRANCISCO-OAKLAND BAY BRIDGE

Contract No.	Description	Estimated Cost Including Contingencies	Estimated Total Work Done to July 1, 1936	Percentage Complete	Contractor
64TC6	Dredger Fill	$961,770.45	$961,770.45	100	American Dredging Co..
64TC8	Rock Wall	279,488.61	279,488.61	100	Fredrickson & Watson and Fredrickson Bros..
64TC16	Pabco Subway	26,336.10	26,336.10	100	Healy-Tibbitts Construction Co.
64TC24 (15A)	San Francisco Approaches	555,000.00	380,000.00	69	Healy-Tibbitts Construction Co.
64TC26-84TC1	Distribution Structure	1,185,000.00	1,160,000.00	98	Barrett & Hilp
64TC29	Folger Avenue Underpass	131,800.63	131,800.63	100	J. F. Knapp
84TC2 (11A)	Lighting Approaches	92,000.00	56,000.00	61	Alta Electric & Mechanical Co., Inc., and American Building Main. Co.
84TC3	San Pablo Underpass	375,000.00	315,000.00	84	J. F. Knapp
84TC4	Mole Paving	271,376.07	149,000.00	55	Hanrahan-Wilcox Corp.
84TC8	Ashby Avenue Connection	31,400.00	11,000.00	35	L. C. Seidel.
84TC9	Landscaping 5th St. Plaza	16,000.00	0	0	California Nursery Co.
84TC10	Cypress St., 34th to 7th	140,000.00	0	0	Hanrahan Co.
	Sodium Vapor Lighting Extension (from Distribution Struct. to Folger Ave.)	31,700.00	0	0	To be done by State forces
	Traffic Stripes	1,825.00	0	0	To be done by State forces
	Traffic Signs—Approaches	18,000.00	0	0	To be done by State forces
	Fencing Special Areas	5,000.00	0	0	To be done by State forces
84T2	Landscaping East Bay Fill	50,000.00	2,078.73	4	(Some plants under development, Contract to be let in Spring, 1937)
	Subtotal	$4,171,696.86	$3,472,474.52	83	
	Engineering	§402,000.00	§333,648.41	84	†Includes $480,152 property used jointly by Highway Approaches and Bridge Interurban Railway.
	Subtotal	$4,573,696.86	$3,806,122.93		
	Property	†2,220,000.00	†2,037,169.47	92	
	Totals	$6,793,696.86	$5,843,292.40	86	

§ Includes Preliminary Investigations, borings, surveys, design, construction, laboratory and R.O.W. Engr. Complete.

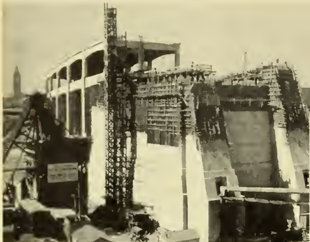
PICTORIAL PROGRESS

OF

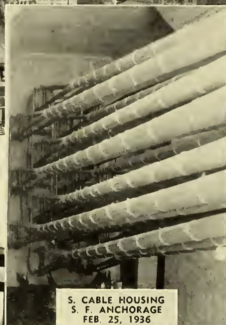
SAN FRANCISCO-OAKLAND BAY BRIDGE

PAGES 70 TO 84 INCLUSIVE

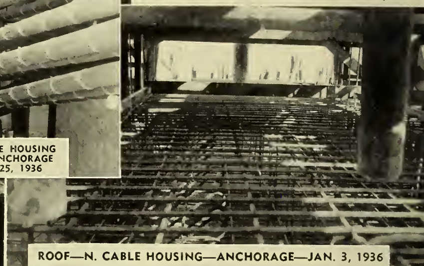
CONTRACT 3—SAN FRANCISCO ANCHORAGE


SAN FRANCISCO ANCHORAGE—APRIL 1, 1936


SAN FRANCISCO ANCHORAGE—JUNE 2, 1936

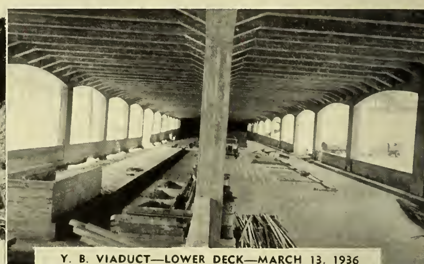

S. CABLE HOUSING
S. F. ANCHORAGE
FEB. 25, 1936


SAN FRANCISCO ANCHORAGE—JUNE 18, 1936


ROOF—N. CABLE HOUSING—ANCHORAGE—JAN. 3, 1936

CONTRACT 5—YERBA BUENA ANCHORAGE AND SPANS

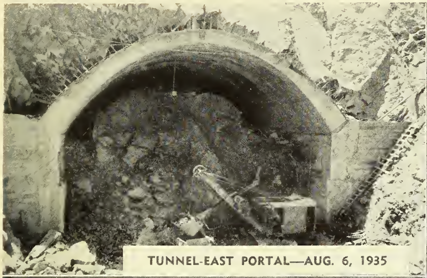

YERBA BUENA ANCHORAGE—AUG. 6, 1935

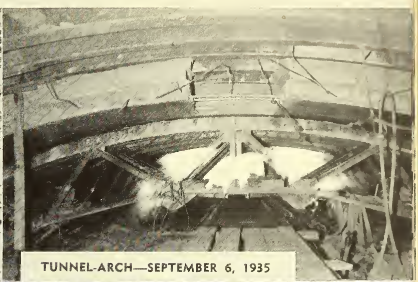

Y. B. VIADUCT—LOWER DECK—MARCH 13, 1936


YERBA BUENA ANCHORAGE—MAY 19, 1936


YERBA BUENA VIADUCT—JUNE 9, 1936

CONTRACT 5—YERBA BUENA TUNNEL

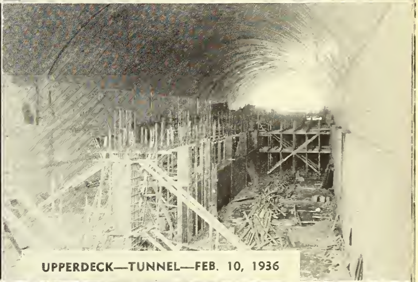

TUNNEL-EAST PORTAL—AUG. 6, 1935


TUNNEL-ARCH—SEPTEMBER 6, 1935

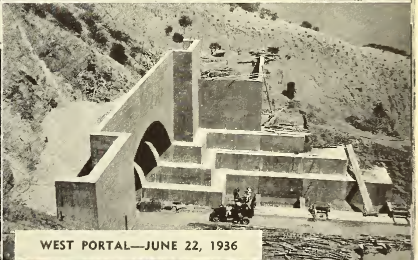

TUNNEL-CORE—SEPTEMBER 26, 1935


TUNNEL-ARCH—OCTOBER 2, 1935

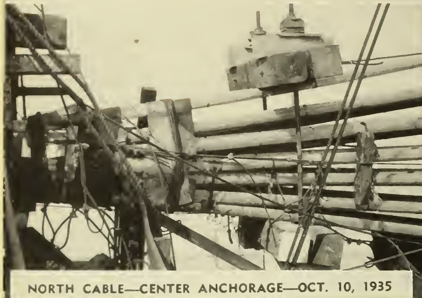

TUNNEL—NOVEMBER 26, 1935


UPPERDECK—TUNNEL—FEB. 10, 1936


EAST PORTAL—JANUARY 27, 1936


WEST PORTAL—JUNE 22, 1936

CONTRACT 6—CABLE SPINNING


NORTH CABLE—CENTER ANCHORAGE—OCT. 10, 1935


NORTH CABLE—S. F. ANCHORAGE—NOV. 5, 1935


YERBA BUENA ANCHORAGE—NOV. 26, 1935


NO. & SO. CABLES—S. F. ANCHORAGE—NOV. 14, 1935

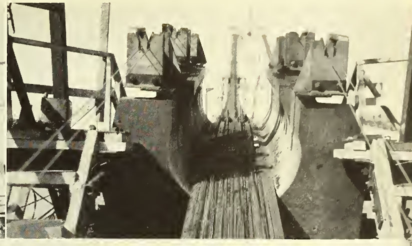

NORTH CABLE
S. F. ANCHORAGE
OCTOBER 4, 1935


SOUTH CABLE
SADDLE W5
NOVEMBER 13, 1935

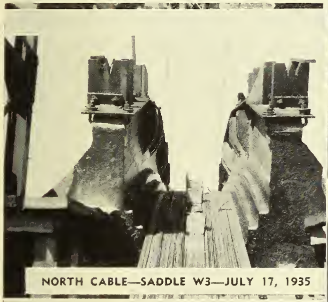

NORTH CABLE
MIDSPAN ANCHORAGE—W1
OCTOBER 8, 1935

CONTRACT 6—CABLE SPINNING

NORTH CABLE—S. F. ANCHORAGE—JULY 1, 1935



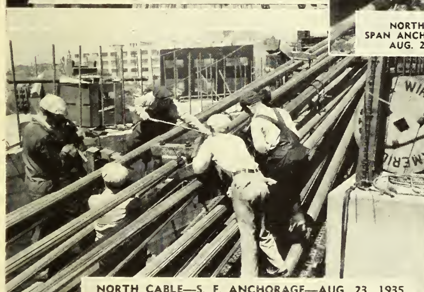
NORTH CABLE—SADDLE W1—JULY 17, 1935



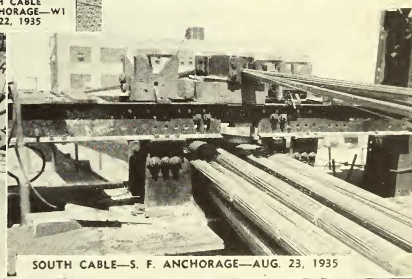
NORTH CABLE—SADDLE W3—JULY 17, 1935

NORTH CABLE
SPAN ANCHORAGE—W1
AUG. 22, 1935

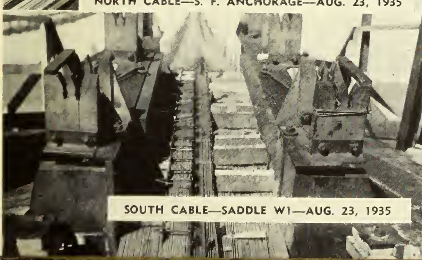
NORTH CABLE—S. F. ANCHORAGE—AUG. 23, 19



NORTH CABLE—S. F. ANCHORAGE—AUG. 23, 1935



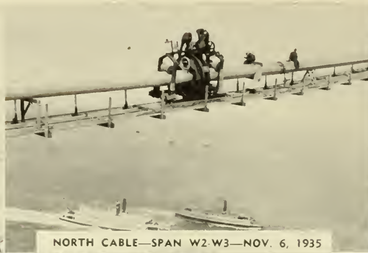
SOUTH CABLE—S. F. ANCHORAGE—AUG. 23, 1935



SOUTH CABLE—SADDLE W1—AUG. 23, 1935

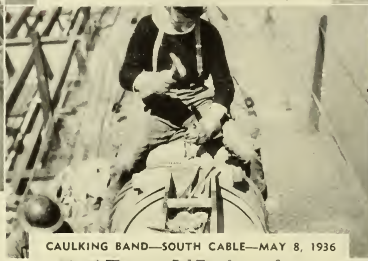
NORTH CABLE—SADDLE W1—OCTOBER 3, 1935

NORTH CABLE
SPAN W1-W2
NOV. 14, 1935



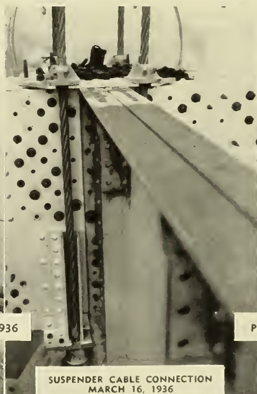
NORTH CABLE—SPAN W2-W3—NOV. 6, 1935

SQUEEZING NO. CABLE
S. F. ANCHORAGE
OCTOBER 10, 1935

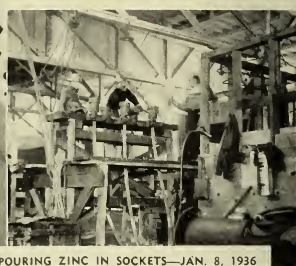


CAULKING BAND—SOUTH CABLE—MAY 8, 1936

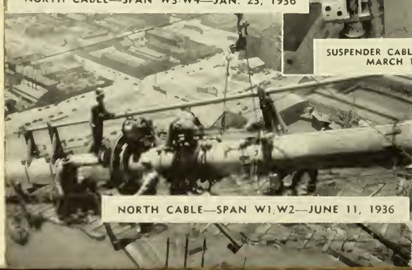
NORTH CABLE—SPAN W3-W4—JAN. 23, 1936



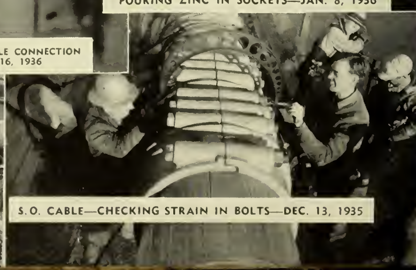
SUSPENDER CABLE CONNECTION
MARCH 16, 1936



POURING ZINC IN SOCKETS—JAN. 8, 1936

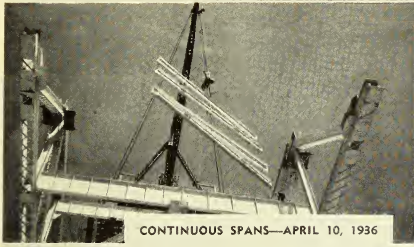


NORTH CABLE—SPAN W1-W2—JUNE 11, 1936

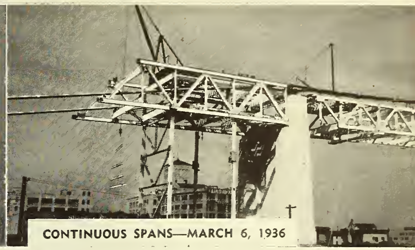


S.O. CABLE—CHECKING STRAIN IN BOLTS—DEC. 13, 1935

CONTINUOUS SPANS

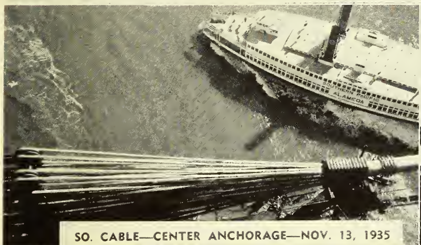


CONTINUOUS SPANS—APRIL 10, 1936

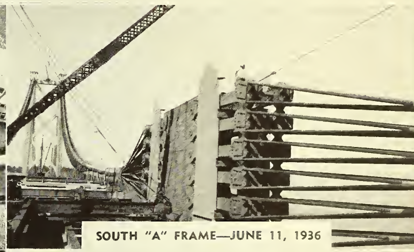


CONTINUOUS SPANS—MARCH 6, 1936

CENTER ANCHORAGE



SO. CABLE—CENTER ANCHORAGE—NOV. 13, 1935



SOUTH "A" FRAME—JUNE 11, 1936

CENTER ANCHORAGE—MARCH 24, 1936

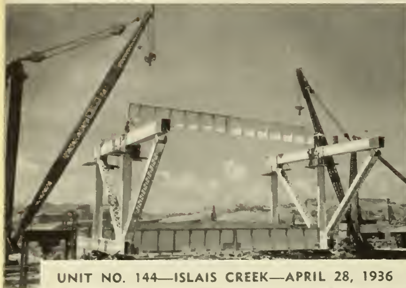
CENTER ANCHORAGE—JUNE 12, 1936

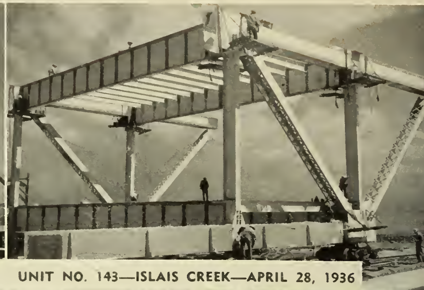
PAVING

SPAN W3-W4—JUNE 26, 1936

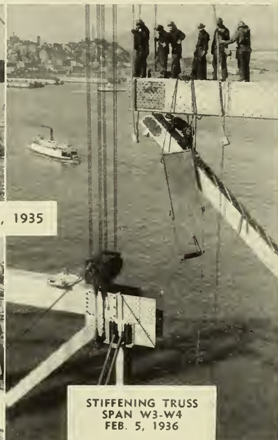
LOWER DECK—SPAN W2-W3—JUNE 29, 1936

CONTRACT 6—STIFFENING TRUSSES


UNIT NO. 144—ISLAIS CREEK—APRIL 28, 1936


UNIT NO. 143—ISLAIS CREEK—APRIL 28, 1936


UNIT NO. 1—STIFFENING TRUSS—DEC. 18, 1935

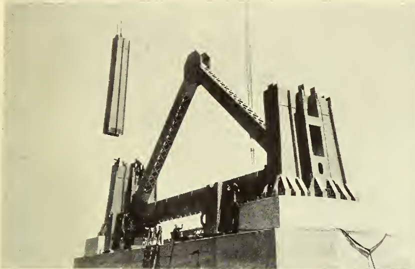

STIFFENING TRUSS
SPAN W3-W4
FEB. 5, 1936


STIFFENING TRUSS
SPAN W2-W3
MARCH 9, 1936

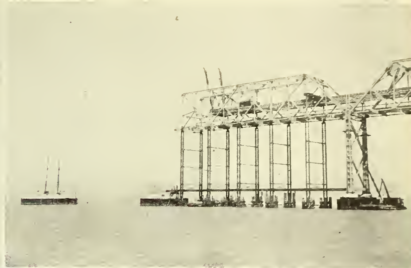

UNIT NO. 1—STIFFENING TRUSS-SPAN W3-W4—DEC. 18, 1935


STIFFENING TRUSS—SPAN W1-W2—MARCH 10, 1936

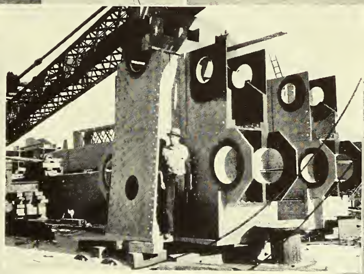

STIFFENING TRUSS
SPAN W2-W3
JAN. 22, 1936



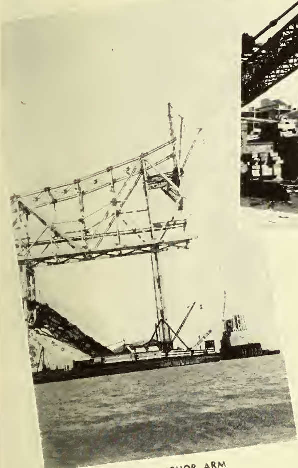
TOWER E-2—JULY 8, 1935



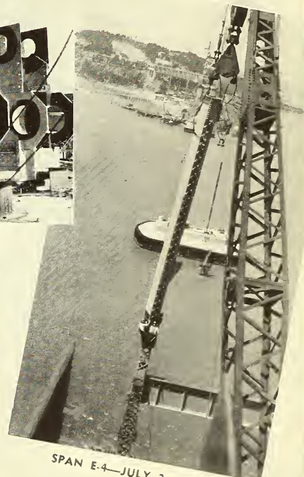
SPAN E-4—JULY 8, 1935



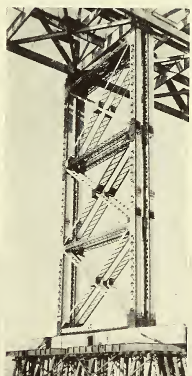
TOWER E-3 SHOES—SEPT. 12, 1935



WEST ANCHOR ARM
JULY 8, 1935

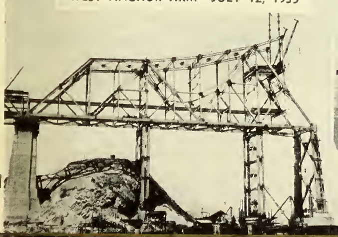


SPAN E-4—JULY 2, 1935

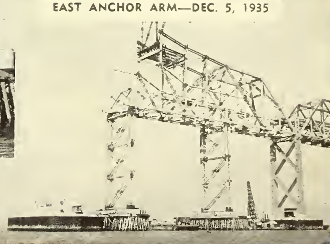


FALSEWORK
EAST ANCHOR ARM
DEC. 13, 1935

WEST ANCHOR ARM—JULY 12, 1935



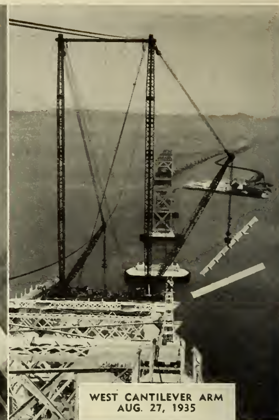
EAST ANCHOR ARM—DEC. 5, 1935



CANTILEVER

EAST CANTILEVER ARM
JAN. 6, 1936

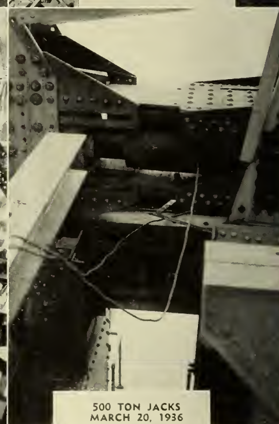
WEST CANTILEVER ARM
AUG 27, 1935



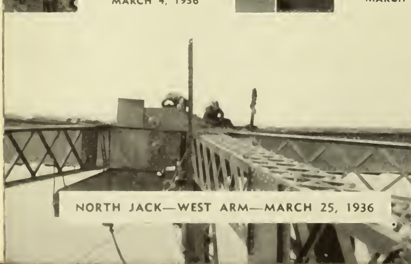
WEST CANTILEVER ARM
AUG. 27, 1935

EAST CANTILEVER ARM
MARCH 4, 1936

SUSPENDED SPAN
MARCH 22, 1936



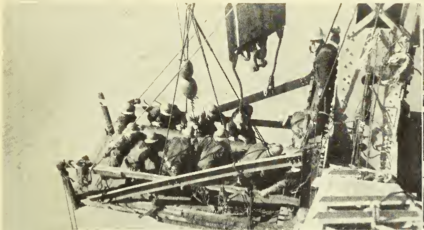
500 TON JACKS
MARCH 20, 1936



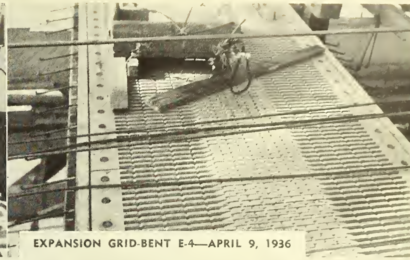
NORTH JACK—WEST ARM—MARCH 25, 1936

PUMP & SO. JACK—WEST ARM—MARCH 25, 1936

CANTILEVER



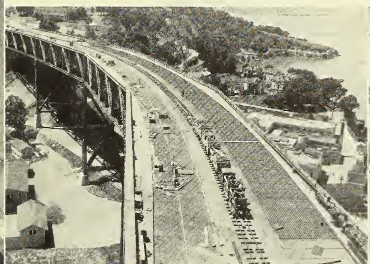
DRIVING PIN—PANEL POINT LS6—MARCH 25, 1936



EXPANSION GRID-BENT E-4—APRIL 9, 1936

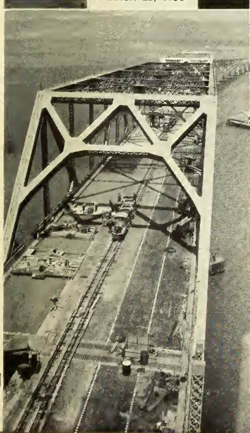
SUSPENDED SPAN
MARCH 23, 1936

PAVING



Y. B. SPANS—MAY 7, 1936

SUSPENDED SPAN
EAST ARM
MAY 15, 1936



CANTILEVER SPAN—JUNE 25, 1936

SPAN E-4
UPPER DECK
JUNE 1, 1936

SPAN E-4
JUNE 25, 1936

CONTRACT 9—PAINTING

PAINTING RAIL—SPAN E5—DEC. 19, 1935

SO. CABLE—SPAN ANCHORAGE-W1—MAY 13, 1936

SUSPENDER CABLES
SPAN W4-W5
MAY 12, 1936

SUSPENDER CABLES—SPAN W5-W6—MAY 21, 1936

SOUTH CABLE—CENTER ANCHORAGE—MAY 21, 1936

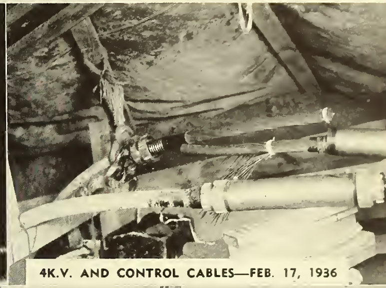
CONTRACT 10—ADMINISTRATION BUILDING

ADMINISTRATION BUILDING—JUNE 15, 1936

TOLL PLAZA—JUNE 15, 1936

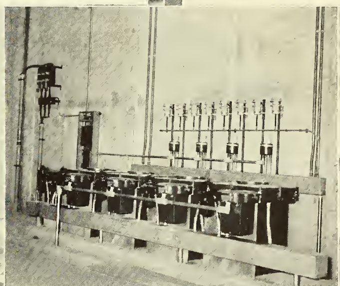
CONTRACT 11—ELECTRICAL WORK

SPLICING 166 CONDUCTOR—FEB. 20, 1936



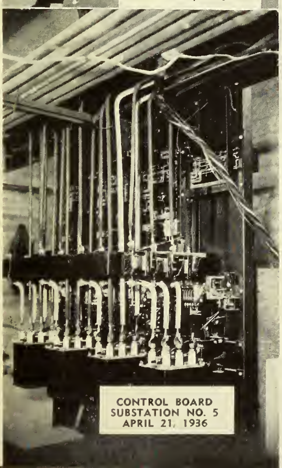
4K.V. AND CONTROL CABLES—FEB. 17, 1936

AIRPLANE BEACON
SPAN E-5
DEC. 20, 1935

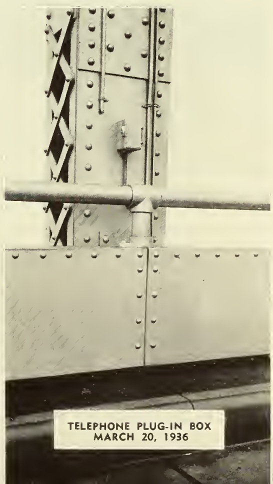


SUBSTATION NO. 6—JUNE 15, 1936

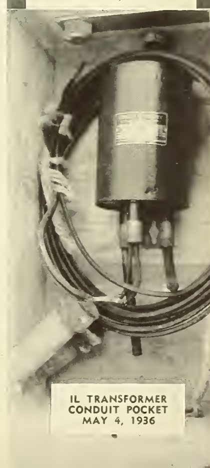
POLICE TELEPHONE BOX
SPAN E-10
MAY 20, 1936



CONTROL BOARD
SUBSTATION NO. 5
APRIL 21, 1936



TELEPHONE PLUG-IN BOX
MARCH 20, 1936



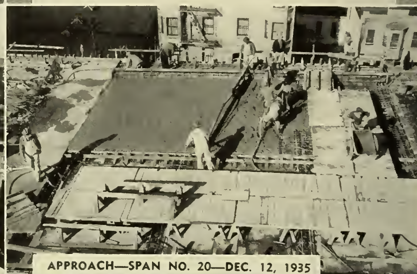
IL TRANSFORMER
CONDUIT POCKET
MAY 4, 1936

SAN FRANCISCO APPROACHES


S. F. APPROACH—JUNE 24, 1935


APPROACH—THIRD STREET CROSSING—DEC. 12, 1935

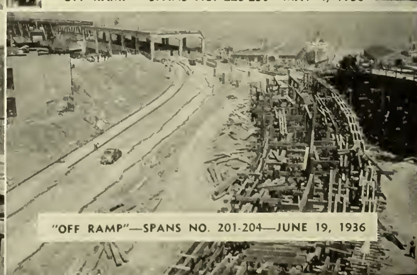

S. F. APPROACH—MAY 4, 1936


APPROACH—SPAN NO. 20—DEC. 12, 1935


"ON RAMP"—JUNE 29, 1936


"OFF RAMP"—SPANS NO. 228-230—MAY 4, 1936

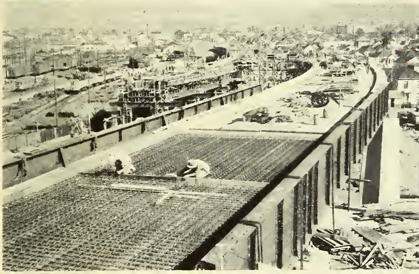

"OFF RAMP"—SPANS NO. 225-230—MAY 13, 1936


"OFF RAMP"—SPANS NO. 201-204—JUNE 19, 1936

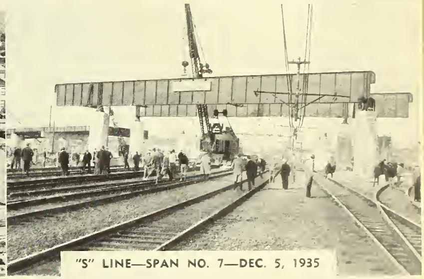
DISTRIBUTION STRUCTURES

FOOTING—BENT NO. 7-"S" LINE—OCT. 9, 1935

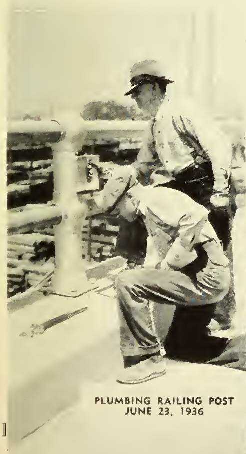
"CS" LINE—SPANS NO. 11-NO. 24—OCT. 23, 1935



"SB" LINE—SPANS NO. 6-NO. 11—OCT. 23, 1935



"S" LINE—SPAN NO. 7—DEC. 5, 1935



PLUMBING RAILING POST
JUNE 23, 1936

SPAN NO. 7
"S" LINE
DEC. 5, 1935

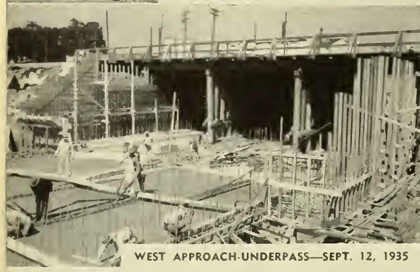
"CS" LINE—SPANS NO. 5-NO. 6—OCT. 9, 1935

"AN" AND "BN" LINES—MAY 15, 1936

FOLGER AVENUE

LIFTING PRECAST SLAB—NOV. 6, 1935

FALSEWORK PILES—AUG. 29, 1935

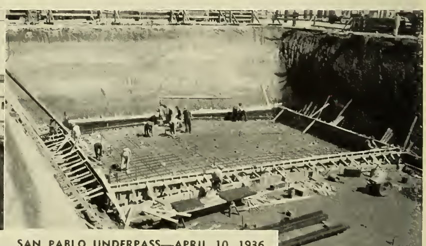


WEST APPROACH-UNDERPASS—SEPT. 12, 1935

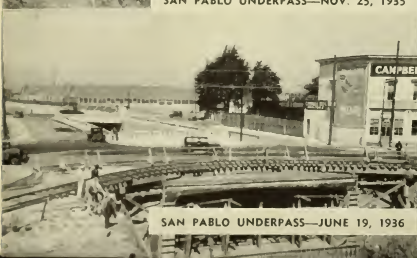
FOLGER AVENUE UNDERPASS—DEC. 3, 1935

SAN PABLO

SAN PABLO UNDERPASS—NOV. 25, 1935



SAN PABLO UNDERPASS—APRIL 10, 1936



SAN PABLO UNDERPASS—JUNE 19, 1936

SAN PABLO CROSSING—JUNE 23, 1936

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INDEX TO ILLUSTRATIONS

STATE OF CALIFORNIA

DEPARTMENT OF PUBLIC WORKS

SAN FRANCISCO-OAKLAND BAY BRIDGE

ADMINISTRATION BUILDING AND TOLL PLAZA

CONTRACT NO. 10

Bids Opened
July 26, 1935, 2:00 P. M.
Room 811, 500 Sansome St. S.F.

TABULATION OF BIDS

ITEM	QUANTITY	UNIT	DESCRIPTION	CLINTON CONSTRUCTION CO. OF CALIFORNIA, 923 FOLSOM, S.F. CALIF.		McDONALD & KAHN COMPANY LTD., 200 FINANCIAL CENTER BLDG., S.F. CALIF.		DINWIDDIE CONSTRUCTION CO., 210 CROCKER BLDG., S.F. CALIF.		BATES & ROGERS, BOX 883, OAKLAND CALIF.	
			Bidder's Bond	$40 000.00		$60 000.00				$45 000.00	
			Certified Check					$40 000.00			
				UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT
1	17500	Cubic Yards	Excavation	.57	9975 -	.70	12250 -	1.40	24500 -	1.25	21875 -
2	660	Each	Driving Timber Piles	20 -	13200 -	45 -	29700 -	35 -	23100 -	34 -	22440 -
3	550	Cubic Yards	Concrete Seal	25 -	13750 -	13 -	7150 -	10.50	5775 -	9.80	5390 -
4	1500	Cubic Yards	Foundation Concrete	9.30	13950 -	10 -	15000 -	8 -	12000 -	12 -	18000 -
5	2200	Cubic Yards	Structural Concrete	13 -	28600 -	15 -	33000 -	12.30	27060 -	15.50	34100 -
6	40	Cubic Yards	Concrete Railings	38 -	1520 -	50 -	2000 -	41 -	1640 -	34.15	1366 -
7	600000	Pounds	Reinforcing and Miscellaneous Steel	.041	24600 -	.038	22800 -	.0385	23100 -	.0395	23700 -
8			Waterproofing, Lump Sum		1600 -		2000 -		1400 -		1520 -
9	1300	Cubic Yards	Selected Base Material	1.74	2262 -	1.25	1625 -	.90	1170 -	1.67	2171 -
10	2000	Tons	Crusher Run Base	2.30	4600 -	1.50	3000 -	1.25	2500 -	2.20	4400 -
11	2000	Tons	Asphalt Concrete	4.85	9700 -	5 -	10000 -	4 -	8000 -	4.65	9300 -
12	2	Each	Truck Scales, 30-foot, 30 Tons	2100 -	4200 -	2000 -	4000 -	1598.50	3197 -	1910 -	3820 -
13	2	Each	Truck Scales, 60-foot, 40 Tons	2900 -	5800 -	3000 -	6000 -	1821 -	3642 -	2615 -	5230 -
14			Administration Building, General Const., Lump Sum		127500 -		114167 -		143000 -		137323 -
15			Toll Booths & Canopies, General Const., Lump Sum		32800 -		35000 -		29000 -		41910 -
16			Heating and Plumbing, Lump Sum		20400 -		20000 -		19397 -		23660 -
17			Electrical Work, Lump Sum		40000 -		42000 -		42000 -		42785 -
18			Administration Building, Steel Furniture, Lump Sum		2800 -		3000 -		1851 -		2910 -
19	2	Each	Flag Poles	300 -	600 -	250 -	500 -	296 -	592 -	300 -	600 -
20	2000	Barrels	Extra Portland Cement	1.50	3000 -	1.25	2500 -	2.185	4370 -	2.25	4500 -
			TOTALS		360857 -		365692 -		377294 -		407000 -

ITEM	QUANTITY	UNIT	DESCRIPTION	FREDERICK & WATSON CONSTRUCTION CO. & FREDERICKSON BROS, 373-81 ST. AVE, OAKLAND CALIF.		CAHILL BROS. INC., 206 SANSOME ST., S.F. CALIF.		BARRETT & HILP, 918 HARRISON ST., S.F. CALIF.	
			Bidder's Bond	$45 000.00		$45 000.00		$50 000.00	
			Certified Check						
				UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT	UNIT PRICE	AMOUNT
1	17500	Cubic Yards	Excavation	2 -	35000 -	2 -	35000 -	2 -	35000 -
2	660	Each	Driving Timber Piles	15 -	9900 -	16 -	10560 -	45 -	29700 -
3	550	Cubic Yards	Concrete Seal	13 -	7150 -	9.60	5280 -	14 -	7700 -
4	1500	Cubic Yards	Foundation Concrete	15 -	22500 -	11 -	16500 -	12 -	18000 -
5	2200	Cubic Yards	Structural Concrete	17 -	37400 -	19.50	42900 -	18 -	39600 -
6	40	Cubic Yards	Concrete Railings	35 -	1400 -	40 -	1600 -	50 -	2000 -
7	600000	Pounds	Reinforcing and Miscellaneous Steel	.04	24000 -	.045	27000 -	.0425	25500 -
8			Waterproofing, Lump Sum		1600 -		1650 -		2800 -
9	1300	Cubic Yards	Selected Base Material	1.25	1625 -	2.25	2925 -	1.80	2340 -
10	2000	Tons	Crusher Run Base	2 -	4000 -	2.65	5300 -	2.50	5000 -
11	2000	Tons	Asphalt Concrete	5 -	10000 -	5.50	11000 -	5.20	10400 -
12	2	Each	Truck Scales, 30-foot, 30 Tons	2100 -	4200 -	2200 -	4400 -	2100 -	4200 -
13	2	Each	Truck Scales, 60-foot, 40 Tons	3250 -	6500 -	3050 -	6100 -	3000 -	6000 -
14			Administration Building, General Const., Lump Sum		123000 -		151190 -		144200 -
15			Toll Booths & Canopies, General Const., Lump Sum		58000 -		36349 -		31500 -
16			Heating and Plumbing, Lump Sum		24000 -		24000 -		23000 -
17			Electrical Work, Lump Sum		45500 -		46000 -		40000 -
18			Administration Building, Steel Furniture, Lump Sum		2700 -		2000 -		3300 -
19	2	Each	Flag Poles	300 -	600 -	350 -	700 -	650 -	1300 -
20	2000	Barrels	Extra Portland Cement	2.10	4200 -	2.47	4940 -	2.25	4500 -
			TOTALS		423275 -		435394 -		436040 -

STATE OF CALIFORNIA

DEPARTMENT OF PUBLIC WORKS

SAN FRANCISCO-OAKLAND BAY BRIDGE

ADMINISTRATION BUILDING AND TOLL PLAZA

CONTRACT NO 10

Bids Opened
July 26, 1935, 2:00 P.M.
Room 511, 500 Sansome St. S.F.

ITEM	QUANTITY	UNIT	DESCRIPTION
1	17500	Cubic Yards	Excavation
2	800	Each	Driving Timber Piles
3	550	Cubic Yards	Concrete Seal
4	1500	Cubic Yards	Foundation Concrete
5	2200	Cubic Yards	Structural Concrete
6	40	Cubic Yards	Concrete Railings
7	500000	Pounds	Reinforcing and Miscellaneous Steel
8			Waterproofing Lump Sum
9	1500	Cubic Yards	Selected Base Material
10	2000	Tons	Crusher Run Base
11	2000	Tons	Asphalt Concrete
12	2	Each	Truck Scales 30 ft 30 Tons
13	1	Each	Truck Scales 20-foot, 15 Tons
14			Administration Building General Const. Lump Sum
15			Toll Booths & Canopies General Const. Lump Sum
16			Heating and Plumbing Lump Sum
17			Electrical Work Lump Sum
18			Administration Building Steel Furniture Lump Sum
19	2	Each	Flag Poles
20	2000	Barrels	Extra Portland Cement

TOTALS


STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SAN FRANCISCO-OAKLAND BAY BRIDGE
PROGRESS CHART
YERBA BUENA ISLAND
CORRECTED TO JUNE 30, 1936
PREVIOUS PROGRESS
PROGRESS LAST MONTH
TO SAN FRANCISCO
TO OAKLAND
SUSPENSION
CABLES-100%
CABLES WRAPPED (NO MESH)
ANCHORAGE
VIADUCT
BRIDGE APPROACH
CANTILEVER
Y.B.1
Y.B.2
Y.B.3
Y.B.4
E.1
GROUND LINE AT ¢ OF BRIDGE
DATUM M.L.L.W. 0.00
TUNNEL PER CENT COMPLETE
EXCAVATION
STEEL LINING
CONCRETE
VIADUCT PER CENT COMPLETE
EXCAVATION
FOUNDATION
SUPERSTRUCTURE
VIADUCT-ANCHORAGE TO WEST PORTAL
COMPLETION DATES
EXCAVATION 99% - 1936
FOUNDATION 96% - 1936
SUPERSTRUCTURE 90% 1936
(COMPLETE EXCEPT FOR WALL ON SO. SIDE BET. BENT 1 & 2 & HANDRAIL)
PROGRESS - VIADUCT - EAST PORTAL TO PIER Y.B.1.
COMPLETION DATES
EXCAVATION SEPT. 1, 1935
FOUNDATION SEPT. 3, 1935
SUPERSTRUCTURE JUNE 6, 1936
TYPICAL TUNNEL SECTION
EXCAVATION LEGEND
PROGRESS OF YERBA BUENA TUNNEL
EXCAVATION
540 FT. TUNNEL
CONCRETE
COMPLETION DATES
EXCAVATION
I JULY 27, 1934
II JULY 14, 1934
III OCT. 17, 1934
IV NOV. 8, 1934
V OCT. 6, 1934
VI OCT. 12, 1935
VII OCT. 12, 1935
VIII NOV. 27, 1935
IX JAN. 21, 1935
X NOV. 20, 1934
XI JAN. 30, 1936
XII 1936
S.L. OCT. 16, 1935
CONCRETE
A MAR. 2, 1935
B APR. 4, 1935
C OCT. 19, 1935
D MAR. 20, 1936
E 40% 1936
R.G. NOV. 5, 1935
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
SECTION E-E
SECTION F-F
EXCAVATION
GROUND LINE
VIADUCT TYPICAL SECTION
UPPER DECK
LOWER DECK
BENT #5 - 155+73.5 WEST OF TUNNEL
(SIDEWALKS, CURBS AND GUTTERS) BENT 6 TO WEST PORTAL
(CONCRETE SLAB EAST PORTAL-50A)
(SIDEWALKS, CURBS AND GUTTERS) EAST PORTAL TO YB1.
BENT #45 - 166+53.5 EAST OF TUNNEL
ANCHORAGE
NORTH & SOUTH WALLS
CONCRETE COMPLETE 6-30-36
LEGEND
YERBA BUENA ANCHORAGE
ANCHORAGE TUNNELS
SECTIONS
PLAN OF ANCHORAGE TUNNELS
NORTH TUNNEL
SOUTH TUNNEL
SECTION-ANCHORAGE TO WEST PORTAL
TYPICAL TUNNEL SECTION
CONCRETE LEGEND
(SIDEWALK, CURBS AND GUTTERS COMPLETED)
SECTION EAST PORTAL TO BENT NO. 48A
PIER Y.B.1.
PIER Y.B.2.
PIER Y.B.3.
PIER Y.B.4.
PIER E.1.
EXCAVATION
FOUNDATIONS
PIER SHAFT
COMPLETE
ANCHORAGE
NORTH CABLE BENT
CABLE WRAPPED
CABLE-100%
CABLE BENT AND ANCHOR CHAINS SOUTH TUNNEL
(NORTH TUNNEL IDENTICAL)
PLAN
NORTH TUNNEL


SAN FRANCISCO
SEC. B-B
CONTINUOUS SPAN ERECTION
SAN FRANCISCO ANCHORAGE
CABLES WRAPPED
FLOOR STEEL-APRIL
MARCH
WEST SPAN
CENTER ANCHORAGE
FLOOR STEEL-MAY
EAST SPAN
FLOOR STEEL-JUNE
YERBA BUENA ISLAND
SEC. A-A.
SEC. C-B.
YERBA BUENA ANCHORAGE
2310'
1160'
NORTH CABLE
SOUTH CABLE
WEST HALF OF BRIDGE
EAST HALF OF BRIDGE
SAN FRANCISCO ANCHORAGE
SEC A-A
PIER A
PIER B
PIER 1
PIER 2
PIER 3
PIER 4
PIER 5
PIER 6
ANCHORAGE
EXTERIOR WALLS
LOWER DECK BEAMS, GIRDERS, SLABS AND SIDEWALKS ON INTERURBAN SIDE AND ROADWAY SIDE ARE COMPLETED.
PROGRESS OF STEELWORK
CAISSON
PIER 4
CENTER ANCHORAGE
STEEL SHROUD
TREMIE SEAL
PIER AND FENDER
TUNNEL SECTIONS
PREVIOUS PROGRESS
PROGRESS LAST MONTH
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SAN FRANCISCO-OAKLAND BAY BRIDGE
PROGRESS CHART
WEST BAY CROSSING
CORRECTED TO JUNE 30, 1936

YERBA BUENA ISLAND
1400' CANTILEVER
504' SPANS
288' SPANS
OAKLAND
LAST PIN DRIVEN - 3-25-36
SPOT PAINTING - 96% - 6-30-36
MEAN LOWER LOW WATER
TO SAN FRANCISCO
YB1 YB2 YB3 YB4 E1 E2 E3 E4 E5 E6 E7 E8 E9 E10 E11 E12 E13 E14 E15 E16 E17 E18 E19 E20 E21 E22
PROGRESS OF CAISSONS
PLAN AND FENDER
PILE DIAGRAMS
544 PILES
308 PILES
297 PILES
324 PILES
PIER YB1
PIER YB2
PIER YB3
PIER YB4
PIER E1
PIER E2
PIER E3
PIER E4
PIER E5
PIER E6
PIER E7
PIER E8
PIER E9
PIER E10
PIER E11
PIER E12
PIER E13
PIER E14
PIER E15
PIER E16
PIER E17
PIER E18
PIER E19
PIER E20
PIER E21
PIER E22
ARMY WHARF
RECONSTRUCTION
PROGRESS OF STEEL WORK
ERECTION PROGRESS
% COMPLETE
(TRACK CONNECTION INCOMPLETE - 6-30-36)
PREVIOUS PROGRESS
PROGRESS LAST MONTH
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SAN FRANCISCO-OAKLAND BAY BRIDGE
PROGRESS CHART
EAST BAY CROSSING
CORRECTED TO JUNE 30, 1936

EAST BAY CROSSING

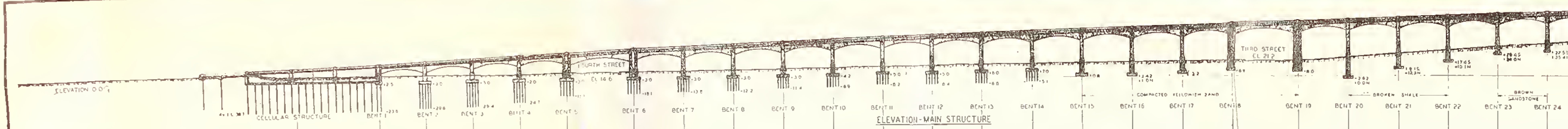
PREVIOUS PROGRESS	
PROGRESS LAST MONTH	

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
SAN FRANCISCO-OAKLAND BAY BRIDGE
PROGRESS CHART
WEST BAY PAVING
EAST BAY PAVING

CORRECTED TO JUNE 30, 1936

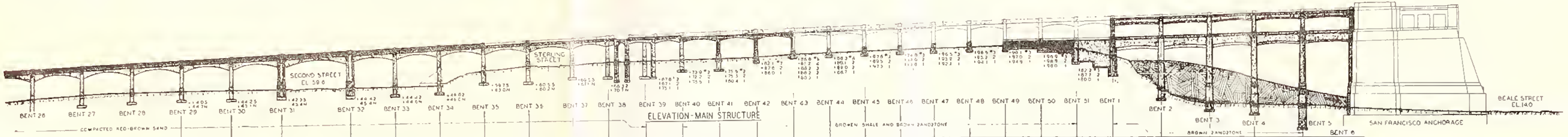
E—Progress Chart West Bay and East Bay Paving

F—Progress Chart San Francisco Approaches



ELEVATION-MAIN STRUCTURE

FOUNDATIONS	EXCAVATION	5-1-36	5-1-36	4-25-35	4-24-35	5-10-35	5-7-35	5-10-35	5-13-35	5-6-35	5-10-35	5-15-35	5-15-35	5-17-35	5-20-35	5-23-35	5-24-35	7-3-35	5-17-35	5-23-35	5-28-35	5-21-35	6-3-35	6-10-35	6-17-35	7-12-35	6-20-35	6-25-35
	PILES	6-18-35	6-18-35	4-8-35	4-12-35	5-7-35	5-1-35	4-30-35	4-23-35	5-2-35	5-6-35	5-7-35	5-9-35	5-13-35	5-14-35	5-17-35	5-22-35	6-27-35	—	—	—	—	—	—	—	—	—	—
	FOOTINGS	5-1-36	5-1-36	4-25-35	4-24-35	5-10-35	5-7-35	5-2-35	4-27-35	5-6-35	5-10-35	5-15-35	5-16-35	5-20-35	5-20-35	5-24-35	5-24-35	7-9-35	5-17-35	5-24-35	5-28-35	5-20-35	6-4-35	6-11-35	6-17-35	7-12-35	6-24-35	7-9-35
	COLUMN BASE	—	—	4-12-35 / 5-17-35	5-8-35	5-17-35	5-16-35	5-10-35	5-13-35	6-5-35	5-28-35	5-28-35	6-5-35	6-5-35	6-5-35	6-11-35	6-11-35	7-16-35	7-9-35	7-10-35	7-10-35	10-9-35	8-2-35	7-19-35	7-19-35	8-7-35	8-5-35	8-7-35
	COLUMN TO GIRDERS	—	—	4-12-35 / 5-17-35	5-17-35	7-11-35	7-11-35	7-30-35	7-30-35	8-15-35	8-14-35	8-21-35	8-23-35	9-4-35	9-6-35	9-18-35	9-18-35	9-30-35	9-30-35	10-10-35	10-11-35	10-30-35	11-14-35	11-14-35	11-25-35	11-25-35	12-3-35	12-16-35
SUPERSTRUCTURE	GIRDERS	—	—	4-29-35	5-23-35	7-11-35	8-12-35	7-30-35	8-30-35	8-16-35	9-11-35	8-28-35	9-20-35	9-10-35	10-3-35	9-20-35	10-17-35	10-1-35	11-1-35	10-18-35	11-4-35	11-22-35	11-19-35	12-5-35	11-29-35	12-5-35	12-28-35	
	SLAB		7 2	5-14-35	6-3-35	8-1-35	8-16-35	8-8-35	9-5-35	8-27-35	9-17-35	9-6-35	9-27-35	9-18-35	10-10-35	9-30-35	10-24-35	10-8-35	11-7-35	10-29-35	11-14-35	12-4-35	12-4-35	12-16-35	12-16-35	12-23-35	1-15-36	
	SIDEWALK			6-21-35	8-9-35	8-27-35	8-27-35	9-11-35	9-4-35	9-25-35	9-13-35	10-3-35	9-28-35	10-21-35	10-4-35	10-29-35	10-22-35	11-13-35	11-5-35	11-22-35	12-9-35	12-9-35	12-20-35	12-20-35	12-26-35	1-17-36		
	RAILING			1-24-36	1-22-36	1-16-36	1-21-36	1-24-36	1-27-36	1-6-36	1-17-36	2-14-36	2-5-36	2-6-36	2-17-36	2-18-36	2-20-36	2-20-36	2-26-36	2-28-36	2-28-36	2-27-36	3-2-36	2-5-36	3-5-36	3-4-36	3-6-36	3-6-36



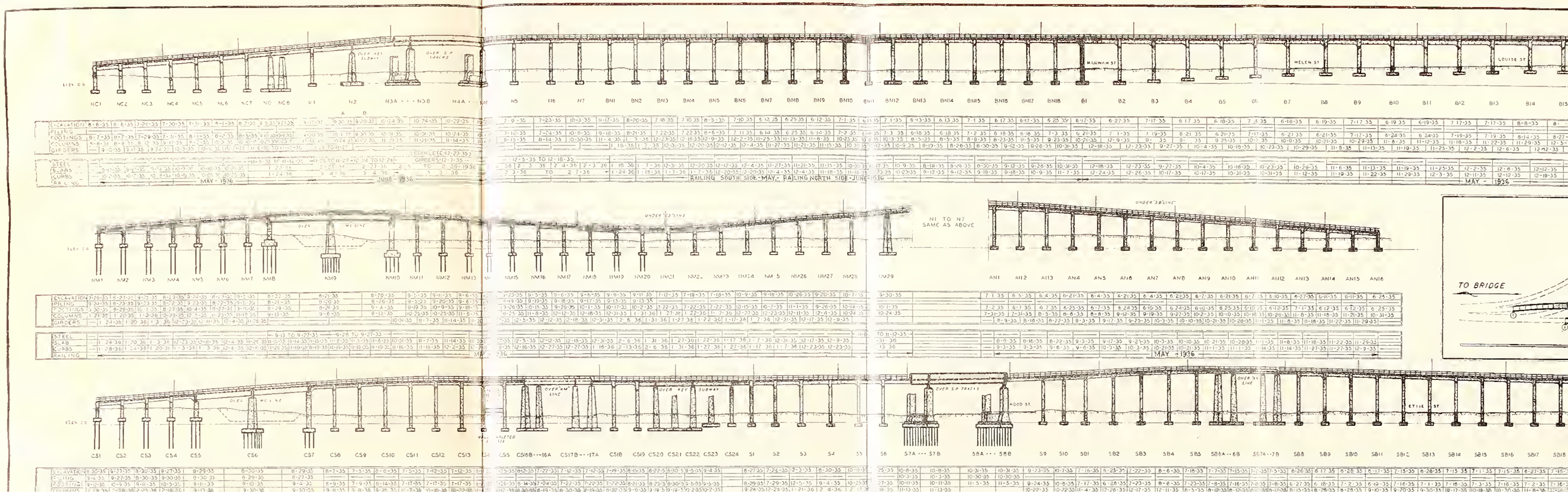
ELEVATION-MAIN STRUCTURE

FOUNDATIONS	EXCAVATION	10-1-35	10-3-35	10-4-35	10-10-35	10-17-35	10-18-35	10-29-35	11-1-35	11-5-35	11-8-35	12-2-35	12-2-35	12-2-35	4-1-36	4-7-36	4-15-36	4-21-36	5-19-36	5-20-36	5-20-36	5-21-36	5-21-36	3-25-36	11-1-34	9-19-34	7-24-34	8-29-34	6-13-34	—
	FOOTINGS	10-1-35	10-3-35	10-4-35	10-10-35	10-17-35	10-18-35	10-29-35	11-1-35	11-5-35	11-8-35	12-2-35	12-2-35	12-2-35	4-1-36	4-7-36	4-15-36	4-21-36	5-19-36	5-20-36	5-20-36	5-21-36	5-21-36	3-25-36	11-15-34	9-20-34	7-25-34	8-29-34	6-13-34	—
	WALL ABOVE FOOTING	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6-15-36	6-11-36	5-20-36	6-8-35	—	—	—	—
	COLUMN BASE	10-22-35	10-21-35	10-24-35	11-27-35	10-31-35	10-30-35	11-6-35	11-11-35	11-2[illegible]-35	12-3-35	12-16-35	12-26-35	1-24-36	4-22-36	5-26-36	5-27-36	6-11-36	6-15-36	6-8-36	6-8-36	8-9-36	6-8-36	4-10-36						
	COLUMN TO GIRDERS	1-20-36	1-29-36	2-13-36	3-9-36	3-6-36	3-17-36	3-27-36	3-27-36	4-1[illegible]-36	4-17-36	4-27-36	5-1-36	6-2-36	6-10-36									4-10-36	5-31-35	5-22-35	4-18-35	4-18-35	4-18-35	5-22-35
SUPERSTRUCTURE	GIRDERS	2-27-35	2-25-36	3-13-36	3-12-36	3-20-36	4-8-36	4-6-36	4-16-36	5-11-36	5-8-36	5-8-36	6-12-36	6-12-36	6-12-36	6-19-36														
	SLAB	3-10-36	3-10-36	3-24-36	3-25-36	4-1-36	4-14-36	4-14-36	4-23-36	5-25-36	5-25-36	5-25-36	6-22-36	6-22-36	6-22-36	6-29-36														
	SIDEWALK	3-17-36	3-17-35	3-27-36	3-27-36	4-7-36	4-17-36	4-17-36	4-24-36	6-1-36	6-1-36	6-1-36																		
	RAILING	6-10-36	6-13-36	6-16-36	6-19-36	6-19-36	6-23-36	S.																						

LOWER DECK	GIRDERS	5-20-36	8-22-35	8-29-35	8-15-35	9-16-35	9-12-35
	ROADWAY SLAB	5-28-36	9-11-35	9-23-35	9-23-35	9-23-35	9-23-35
	RAILWAY SLAB	5-29-36	9-26-35	9-26-35	9-27-35	9-27-35	9-27-35
	CURBS		5-22-36	5-21-36	5-18-35	5-18-36	5-18-36
	RAILING		5-26-36	5-25-36	5-21-36	5-20-36	S. & N.
	COLUMNS BETWEEN DECKS		11-27-35	11-27-35	11-27-35	12-27-35	12-27-35
UPPER DECK	GIRDERS		12-13-35	12-12-35	12-20-35	1-7-36	1-10-36
	ROADWAY SLAB		12-20-35	1-3-36	1-23-36	1-23-36	1-22-36
	SIDEWALK		1-30-36	1-31-36	2-5-36	2-4-36	2-5-36
	RAILING						

ELEVATION-UPPER DECK "ON" RAMP

FOUNDATIONS	EXCAVATION	7-11-35	7-3-35	7-3-35	6-21-35	6-24-35	5-21-35	6-18-35	6-18-35	6-14-35	6-14-35	6-14-35	6-7-35	6-7-35	6-7-35	6-7-35	6-7-35	2-22-35	2-22-35	2-22-35	2-22-35	2-22-35	2-22-35
	FOOTINGS	7-15-35	7-15-35	7-11-35	6-24-35	6-24-35	6-24-35	6-21-35	6-18-35	6-14-35	6-14-35	6-18-35	6-18-35	6-17-35	6-27-35	6-12-35	6-12-35	2-22-35	2-22-35	2-22-35	2-22-35	2-22-35	2-22-35
																	6-27-35	5-23-35	5-23-35	5-23-35	5-23-35	5-23-35	—



OVER S.P. TRACKS
HANNAH ST
HELEN ST
LOUISE ST
EXCAVATION
PILING
FOOTINGS
COLUMNS
GIRDERS
STEEL
SLABS
CURBS
RAILING
MAY - 1936
JUNE - 1936
RAILING SOUTH SIDE-MAY
RAILING NORTH SIDE-JUNE-1936
UNDER "SB" LINE
N1 TO N7 SAME AS ABOVE
TO BRIDGE
OVER "KR" LINE
OVER KEY SUBWAY
OVER S.P. TRACKS
WOOD ST.
ETTIE ST